A. W. Eatman

TEXAS HIGHWAY DEPARTMENT

Construction & Maintenance

BULLETIN No. 6
May, 1951

Highway Shortcourse Issue

This Bulletin is being used as a means of distributing the technical papers, presented at the Twenty-Fifth Annual Highway Short Course at A & M College, for the information of those of you who were unable to attend and for reference or review for you who were present. The material contained herein should prove interesting from the standpoint of highway engineering, construction and operation.

Transcripts on the many impromptu remarks and informal discussions, which contributed greatly to the success of the meeting, are not available.

—D. C. Greer

Foreword

This bulletin is published for the purpose of presenting practical information applicable to current highway problems. These conclusions and data are not necessarily endorsed by the Highway Department nor are they to be construed as instructions. Employees are invited and urged to submit suggestions and relate experiences which would benefit those engaged in the construction and maintenance of highways.

Photographic services are available and other assistance may be obtained if desired in preparing material for submission. All material and comments should be directed to the Chief Engineer, Construction & Maintenance, Austin, Texas.

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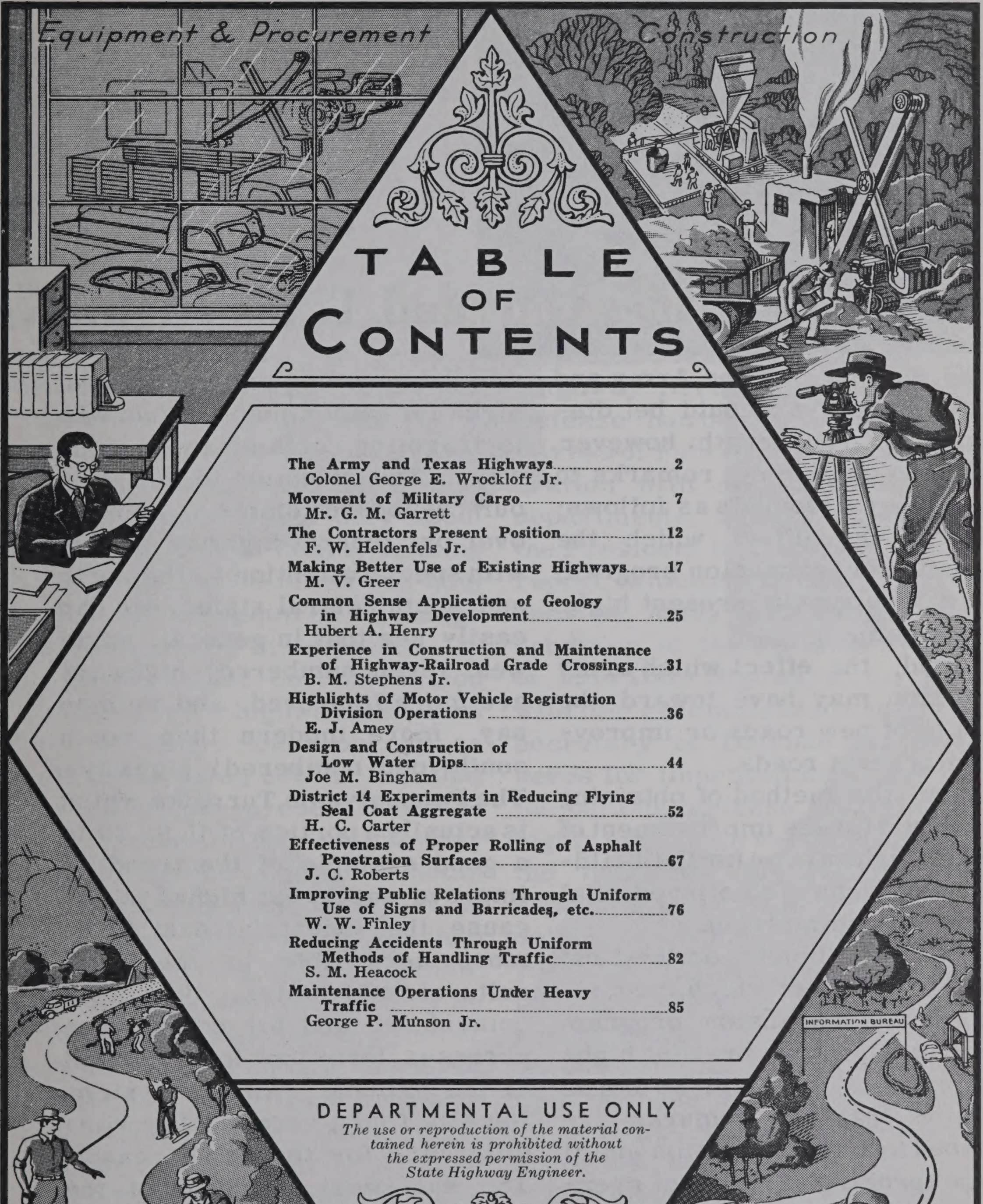

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Colonel George E. Wrockloff Jr.
TRANSPORTATION OFFICER
Headquarters, Fourth Army
Fort Sam Houston, Texas

The Army and Texas Highways

The subject of "The Army and Texas Highways" could be discussed at great length; however, I intend to confine my remarks to three general thoughts as follows:

First, the effect which the current army expansion program may have upon our present highway system.

Second, the effect which army expansion may have toward the building of new roads or improving of present roads.

Third, the method of obtaining federal aid for the improvement of present highways or for the building of new highways believed vital to the defense mission.

Let us dwell briefly on the first thought, the effect which the current army expansion program may have upon our present highway system. It must be borne in mind that my remarks are confined to army expansion and if I were speaking in terms of overall armed forces expansion our problem would be greatly enlarged.

History proves that since the beginning of our nation, the movement of our people has been from east to west direction. As a result, our federal highway system generally favors the individual who is traveling on east or west highways rather than the one who is traveling north or south highways. The exception to this is in our seaboard states. Looking over our federal highway system with special attention to the north and south central states, we can easily see that in general, east-west (even numbered) highways are more improved, and we may say, more modern than north south (odd numbered) highways. The Pennsylvania Turnpike which is actually a portion of U. S. 30 is a good example of the trend to improve east-west highways and cause the industrial east to be more accessible to the agricultural mid-states. Just as a coincidence and for comparison purposes, let us look for a moment at the national railway system. Here we find a very similar condition and for the same reason. The east-west railroads of the central states have in general better service, with a few exceptions of course. They haul more freight. They carry a larger number of passengers. The increasing number of industrial plants now established or being established in the central states has reduced the length of east-west transportation requirements but in general the large percentage of movement is still in those directions. Let us take the case of an individual who desires to travel by rail from New York City to the west coast and another individual who desires to travel from Houston to Duluth, Minnesota. The first individual would travel 3, 000 miles in 62 hours or an average of about 50 miles per hour and would not be required to change cars. The second individual, traveling from Houston to Duluth, would travel only about 1, 500 miles in 41 hours, making an average of 36 miles per hour and would be required to change trains at two or three points.

I realize that our discussion here is to cover highway problems but I wanted to touch on rail as well as to bring out the fact that in view of our present international situation this nation may need to depend upon north-south highways and railroads just as much and possibly more than east-west routes. As we all know, if this nation was attacked by an enemy force, which we hope never becomes an actuality, such an attack could come from the north as well as from the east or west. With this fact in mind, our high level planners are becoming more concerned with the problem of improving all highways, which may become vital in the defense of this country. In this connection, I would like to read an extract of an article published in the November-December, 1949 issue of the National Defense Transportation Journal. This article was written by Col. Ross B. Warren who was then Chief of the Highway Transport Service Division, Office, Chief of Transportation. "Postwar interest in a nationwide system of defense highways has produced tangible evidence indicating the need for a far-reaching program of highway development. In response to the Federal-Aid Highway Act of 1948, a report on 'Highway Needs of the National Defense' has been compiled by the Bureau of Public Roads in co-operation with all state highway departments, and transmitted by the President to Congress. This report, which contains a comprehensive study of the present condition of the National System of Interstate Highways, together with the recommendations of the Secretary of Defense as to the needs for improved highways for the national defense, is based on highly factual surveys and outlines the economic justification for expending more than eleven billion dollars over a period of twenty years to bring the interstate system to a state of adequacy. It recommends a substantially faster rate of improvement to meet the needs of national defense as well as for greater economic and social benefits."

This gives us the unpleasant fact that our present national highway system is in great need of improvement before it can be used effectively in the event of a critical emergency. It also gives us a brief picture of the serious thinking at Washington level as to the need for highway improvement and the long range planning which is being made toward solving this problem.

Let me now turn to our second point in this problem, namely, the effect which army expansion may have toward the building of new roads or toward the necessity of improving present highways. In this connection, I will confine my remarks, as much as possible, to our Texas highways. We may ask ourselves such questions as these: How is the present emergency now affecting our present Texas highways? Do we need some improvement in our present roads? Will the emergency require the building of new roads here in Texas or in our bordering states?

For a considerable length of time it has been agreed among local, state, and military officials that an emergency would show the need for a better highway between the Mexican border and the Oklahoma state line. Therefore, after several months of study by all concerned, the Fourth Army Commander established a priority list of defense highway projects which were deemed essential in the event of a National Emergency. I am sure it will be of interest to you to know that the improvement of U. S. 81 is number one on this priority list. I know that some of you are now wondering what are the conditions which tend to establish such priority. I would like to try to answer this important question. Some of the major conditions which are taken into consideration before recommendations are made toward highway improvements or for the building of new roads are: Present and anticipated traffic counts, necessity for same in connection with the defense program of our nation, rate of accidents, and last but not least, would the improvement of new construction be a benefit to the general public after a National Emergency was terminated?

To stress these points, let us go back to the study of U. S. 81. What did the survey reveal?

First - It showed that traffic counts were at present very high, especially at points where this highway touched or passed through the larger cities such as San Antonio, Austin, and Fort Worth, and as some smaller communities such as Belton and Temple. It showed that by-passes or new routes were urgently needed at some of these points. It was agreed that an emergency would exaggerate this condition.

Second - A review of Texas traffic accident reports showed that the rate of accidents on this highway was high and with the enlarging of army and air force installations along the route, such accident rate would in all probability increase.

Third - Just a glance at the map will show the reason this highway is important as a defense highway. It is the principal route between the important political, defense, and industrial cities of Dallas, Fort Worth, Waco, Austin, and San Antonio. It is one of the principal highways from central United States to the Mexican border. Many important air force and army installations are established along its general route.

Fourth - If U.S. 81 were improved at this time because of the National Emergency, another quick glance at the map will immediately convince even the most conservative that such improvement would be a lasting benefit to the general public after it had completed its mission in the defense program.

Here, I would like to emphasize the point that the Army will not, I'm sure, recommend the construction of new roads or the improvement of present roads which will not, in the future, become a definite public benefit and an over-all improvement to our National Highway System. However, there will be a few exceptions. It will, no doubt, be necessary to build short roads into special projects which, after an emergency, will be of little or no value to the public. I'm sure the Army will do its part to keep each road requirement to a minimum. In this connection, I would like to read another short extract from Col. Warren's article which I quoted in part before: "Foremost among the recommendations of the Secretary of Defense is the improvement of a 'connected system of highways interstate in character' to the highest practical uniform design standards. The National System of Interstate Highways, authorized by the Federal-Aid Highway Act of 1944, consisting of approximately 37, 800 miles and connecting most of the cities in the United States having a population of 50, 000 or more, should provide for the major highway system needs of the Department of Defense. However, changes in military requirements may produce significant changes in the strategic importance of a relatively small mileage of connecting highways which are not a part of the interstate system." Then the article continues on to emphasize that effort will be made to keep such roads to the minimum mileage possible.

I am sure you will also be interested to know that another short highway improvement is being seriously considered here in Texas. This is the improvement and widening, possibly to four lanes, of U.S. 190 from Fort Hood to Belton or U.S. 81, which is approximately twenty miles. I can imagine that some of you are now thinking that this improvement will certainly not benefit the general public after the emergency. That may be partially true; however, I believe you will see the justification for such a project after you hear the general results of the study. The following are some of the facts which were revealed and taken under consideration:

1. Camp Hood became Fort Hood last year. This places this post on a more permanent basis and indicates that travel on U. S. 190 may for many years to come be more dense than had ever been predicted.

2. The present road cannot adequately handle the present peak hour traffic loads. The last survey taken revealed an average 24 hour traffic count of 3, 270 and a peak hour traffic count of about 400 or about seven vehicles per minute.

3. This third finding, no doubt, is the principal reason that this comparatively short section of

road should be improved. During the calendar year 1950, 42 traffic accidents involving military personnel occurred between Belton and Fort Hood. Sixty persons were injured as a result of the accidents; three deaths were recorded. All of these figures are only those resulting from accidents in which military personnel were involved. If civilian accidents were included, these tabulations would, no doubt, be much greater.

After considering the above facts, I believe you will all agree that the project is warranted.

In addition to these two projects which I have mentioned there are several other defense highway improvements under consideration in Texas such as the need for more and better by-passes around our larger Texas cities to speed up traffic in the event of an emergency and those present who spend much time on the highways will, I'm sure, heartily agree to such improvements. Such by-passes will certainly be a benefit to all of us in the future, and I am sure that many city by-pass routes will be constructed regardless of any National Emergency.

Now I would like to touch briefly on the third portion of my remarks, that is, the method of attaining federal aid for the building of new highways or improving highways which are believed vital to the defense mission.

After a particular road has been determined vital to the defense effort and if such road has proved to be inadequate or it appears that an entirely new road is necessary or whatever the case may be, the entire matter is thoroughly studied by concerned installation, local and state officials. If it is agreed that an improvement or new construction is in order, a report is submitted to the Army commander.

Washington has advised us that these reports must contain the following pertinent data:

DATA FOR ACCESS ROAD REQUIREMENTS

1. Agency:
2. Installation:
3. Sketch showing general location of installation and access roads (attached)
4. Status of installation:
5. Type and condition of access roads:

6. Personnel and traffic data:

	Present	Est. by Jan. 1952	Mobilization
a. Military Strength			
b. Civilian Employment			
c. Average daily number of vehicles			
d. Total vehicles during peak hour			
e. Percentage of traffic generated by installation			

f. Type and frequency of vehicles exceeding limitations for general purpose vehicles as prescribed in AR 700-105

7. Access road deficiencies indicated by Agency: (Include photographs when appropriate)

I would like to mention here that recently a report was received at our headquarters which did not contain all of the data which I have just mentioned and for that reason has been returned for complete information. It is not believed that Washington would accept the report unless it provides all the information and data I have just indicated. This particular report was very difficult to prepare because of the restricted nature of the installation in question. Incidentally, it is not a Texas project; however, I wanted to bring this point up to stress the necessity for complete reports.

After a complete report is received by our headquarters, it is studied thoroughly and is then forwarded with the recommendation of the Army commander to the Chief of Transportation in Washington. There it is again thoroughly studied along with any other concerned agencies and finally after passing through other sections, committees, etc., it reaches Congress for necessary appropriation action.

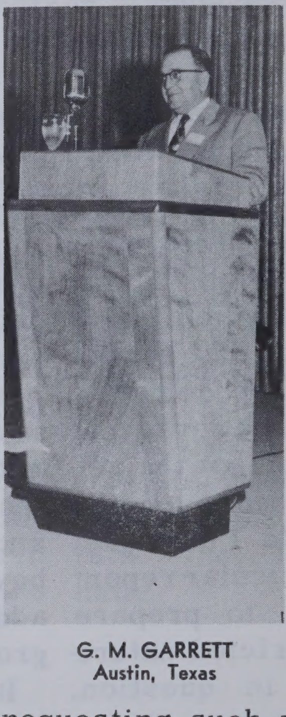
My purpose in relating the channel through which these plans must pass was only to build a somewhat clearer picture as to why action is often delayed on projects of this nature. As you can readily imagine there are many bottlenecks and a good chance for loopholes to be discovered which may require additional study, and "on-the-ground" surveys.

In closing, I would like to again emphasize that our headquarters will continue to think in terms of the taxpayer and will not recommend favorable action on defense highway projects which we do not think are absolutely necessary in the defense of the nation.

Also we will be on the continuous watch to give favorable consideration to these projects which will serve the dual purpose of improving the defense highway system plus providing lasting benefits to the public.

MOVEMENT OF MILITARY CARGO

G. M. GARRETT
Deputy State Highway Engineer
TEXAS HIGHWAY DEPARTMENT



G. M. GARRETT
Austin, Texas

In that our national economy is geared to national defense effort at this time, it is natural that there is going to be from time to time movements of military material which can, or should for reasons of expediency, be moved by way of highways. Control of such movements and military vehicles or commercial vehicles has led to complications as to whom authority for authorization for requesting such permits is to be delegated. The Department of Defense, in trying to improve co-operation with the various states, has arranged for movements of such military goods, either on common or contract carriers, or in its own vehicles, but under the direction of personnel in the military department. The Department of Defense then designated certain of these military officials in the states to consider and act upon requests for permits for oversize and overweight commercial movements of military cargo. For the State of Texas, this authority for the

Federal Government, or Department of Defense, is vested in Col. George E. Wrockloff Jr., Transportation Officer with Headquarters of the Fourth Army, Fort Sam Houston, Texas. Also, the Navy and Air Forces have designated representatives that are authorized to make such requests within the State of Texas.

Under the direction of the Department of Defense, it is the policy for them to conform to state and local laws, regulations and ordinances regulating weight and size limitation of motor vehicles. Limitations on weights and dimensions of vehicular movements over roads and bridges are necessary to insure safe passage over and prevent damage to highway facilities and they provide that no vehicular movement over public highways which exceed any legal limitation, weight or dimension shall be undertaken unless prior permission for such movement is granted by the state or the states concern. They also recognize that limitations on weights and dimensions of vehicular movements will have to be determined independently for each state, in that they may vary considerably in the case of interstate movement. They have adopted a policy that except in urgent military necessity, no vehicular movement which exceeds any legal weight or size limitation would be undertaken over public highways by or for agencies of the Army, Navy, or Air Force, unless prior permission is granted by the state or states concerned. Also, only authorized representatives of the military departments may request permits from the state or states concerned when size and weight limitations are involved. Under no condition shall a carrier be authorized to contact state authorities for such permits. I would like to emphasize this thought, that in case of movement of military cargo, only the authorized representative of the military departments may make requests for permits. Also, I want to call to your attention that in each instance of movement of any oversize or overweight commodities, a report will be made to the Director of the Military Traffic Service, and a full statement of circumstances and justification will be supplied.

Of course our Highway Officials realize that in an all out emergency and a fight to preserve our whole way of living, ordinary routine must be set aside and highways, like our natural and materials resources, would become expendable. Yet, based on our experience and the mistakes made in World War II, we shouldn't expend our highways to a point that we are not going to be able to keep them in such condition as to avoid a complete breakdown of our transportation system. It is for that reason that this method of requesting and authorization of movement of military cargoes was set up.

In case of disagreement or misunderstanding, it is recommended that you contact either Mr. J. A. Waller, Chief Engineer of Construction and Maintenance, or Mr. P. S. Bailey, State Maintenance Engineer, or his authorized personnel, and they will attempt to work your problem out to a satisfactory solution.

In our all out defense economy, we may be confronted with the question of disaster due to enemy attack, and in the case of such disaster, naturally all of our highways leading into and away from such point of disaster will immediately be designated by our Civil Defense Organization as to what equipment, so far as civilians are concerned, will be permitted to go into or out over such routes from the point of disaster.

In cases of disaster of this nature, immediately the question will arise as to "Who does what?" During an emergency of this nature, it is essential that the highways be kept open because Civil Defense and military assistance forces must flow to give relief to the point of disaster, and the highways must be kept free from serious congestion, which would have a tendency to reduce the effectiveness of the outside aid and prevent orderly outward movement of injured and homeless. For this reason the Civil Defense will be charged with the necessity of designating roads that would be closed to local traffic other than that authorized by Civil Defense. Such designations by the Civil Defense would naturally be co-ordinated and agreed to with such military personnel that might be directing military efforts within the vicinity of the point of disaster. These are questions that have not been satisfactorily settled at this time, but I feel sure that sometime within the next 120 days, the Civil Defense Commission will designate such routes that are for the movement of outside aid into a stricken county or city, and also the same Commission will designate secondary routes for movement of injured and homeless from the point of disaster. This would all be worked out with the local Civil Defense, city and county groups, in ample time for the local Civil Defense group to know what to do until such time that the state organization and military authorities could move in, in case of disaster.

I wish to assure you of the Highway Department, as well as others in this audience, that the Texas State Highway Department has pledged full co-operation with the military personnel in the handling of military cargo and commodities over the highway system of the State of Texas. As further directives are received from the military authorities and additional policies of the Highway Department set out, you will be authorized of the same immediately after receipt of such notices and the establishment of such policies that the Highway Commission might desire to place in operation.

I do want to emphasize that in case of an all out emergency and a fight to preserve our whole way of living, we will have to recognize that our highways will have to be expendable to the amount necessary to preserve those liberties which we hold dear, but we don't want to make a mistake and expend our highways to the point that we will break down our highway transportation system. It is necessary that those agents of the

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Highway Department and those agents of the military department co-operate to the fullest extent to route movement of load over roads that we feel can take the punishment with the minimum amount of damage, and except in cases of extreme emergency, we should not permit the placing of overloads over a road that we know cannot take the punishment without causing extreme damage.

* * *

BANQUET SCENES * * *

Mr. A. F. Mitchell receiving plaque . . .

Mr. Marvin Vance . . .

The Contractors Present Position

F. W. HELDENFELS JR.
President, Texas Highway Branch
Associated General Contractors

It is with a great deal of amusement and hesitancy that I tackle this subject -- The Contractor's Present Position -- for a contractor's profit or loss depends on his correct analysis of the current problems facing our industry, and if I had the answer to all of these problems at my finger tips I would know how my profit and loss statement would look at the end of the year. However, I will attempt to review and analyze some of the more serious problems that are confronting us.

F. W. HELDENFELS JR.
Corpus Christi, Texas

During recent months, I have heard several engineers make statements such as the following: "Well, it looks like we are again approaching a time when all a contractor has to do to make money is to be in the business." I would like to correct this viewpoint, if it does exist within the engineering fraternity, as in my opinion a contractor is in a much tougher spot today than he was a year ago because of the many uncertainties arising from the vast National Defense Program.

The first major problem that confronts us when contemplating a continuing highway construction program is the steel shortage. The National Production Authority now estimates that at least 35 per cent of structural steel production will be required in the National Defense Program, and when you add to this all the steel requirements for hospitals, schools in defense areas, and essential industrial expansion which might take priority over highway and bridge construction, we have a very disheartening picture.

We have heard a great deal about increased steel production, and I think it would be pertinent to give you some figures released by Mr. Frank Creedon, assistant administrator of the NPA, to our National AGC Convention on February 27, in regard to increased steel capacity to be anticipated.

The first six months of 1951 we can expect an additional 1,916,000 tons; the second six months of 1951, 2,732,000 additional tons, according to Mr. Creedon. In the first six months of 1952, 3,209,000 additional tons are anticipated, and in the second six months of

1952, another 4,514,000 additional tons, he says; and in the year 1953, another 1,346,000 tons.

The capacity of the steel industry on January 1, 1951, was 104,000,000 tons of steel ingots, and we have just noted an increased production of some 13,700,000 tons over a three-year period, or roughly thirteen per cent. This is an encouraging increase, but it is evident that it will be the latter half of 1952 before this increased steel production can be counted on to relieve any structural shortage in our highway construction program.

The steel situation at the present time is in a state of utter confusion. You, as engineers, do not know what type of structure you can plan to build, and we, as contractors, do not know how much, if any, steel we can obtain and the delivery dates to anticipate.

The best solution to our steel problem would probably be a controlled materials plan. However, the NPA has indicated that the earliest effective date that such a plan could be put into operation would be July 1, 1951.

The Highway Division of the Associated General Contractors of America, at their meeting in Boston last week, passed a resolution supporting the proposed procedure for control of steel for highway work as outlined by a special committee of the AASHO, whereby the National Production Authority was petitioned to make periodic allocations of steel to the Bureau of Public Roads for essential highway work, with the Bureau then distributing this steel allotment to the various states and territories according to the essentiality of the projects and the order of need.

If this system of steel allotment can be initiated, it will do much to clear up the present confused situation, and will be far more satisfactory than the priority system we had for highway construction in the last war, which amounted to nothing more than a hunting license to go out and find the material.

We will go from the steel shortage to the availability of construction equipment, which are related subjects, and I would like to quote here a statement made on February 27 at our Boston meeting by Mr. Ralph K. Stiles, president of the Construction Industry Manufacturers Association:

"Although manufacturers of construction equipment are better tooled for a full-scale war now than before World War II, and have the production capacity, manpower, ability, and desire to serve, they must have materials and components if they are to fill even a portion of the needs of the military and the construction contractor.

"A great many manufacturers in our industry are actually faced with a slowdown or a possible shutdown due to their inability to obtain sufficient materials. Many are being forced to purchase materials on the grey or black market. Thousands of tons of steel in various forms are being imported from Europe at prohibitive costs, in an effort to keep going and hold manpower in peace."

The estimated construction equipment requirements of the military are staggering. It is estimated that they will require only approximately 6,000 motor graders this year, while an average of 8,000 per year of all sizes are manufactured. They will require practically all of the popular sizes of our crawler tractors, and will take something like 50 per cent of the current production of shovels, draglines, rollers and compressors.

You will undoubtedly see large stockpiles of this equipment standing idle, but stockpiles are necessary in modern warfare. Each division calls for a tremendous amount of equipment, and it must be on hand to move when the troops move out.

The equipment requirements listed above are the estimated requirements of the military, and do not include the equipment that might be required for essential defense construction that might be given priority over our highway construction program, so it is apparent that there will be little, if any, new construction equipment available for the highway contractor for at least one to two years.

However, I do not think we need to become alarmed about this equipment situation, as it is my opinion, and also a cross-section opinion of the contractor members of the Texas Highway Branch, that there is now a large quantity of idle highway construction machinery stored in contractor's yards, and that we can build your current highway construction program, or even an expanded program, with construction machinery now on hand.

It will be essential that a sufficient supply of repair parts be made available for maintaining this equipment, and it is urged that the Bureau of Public Roads make every effort to impress on the NPA the essentiality of providing maintenance and repair parts to keep our construction program rolling.

There are other shortages, such as rubber and railroad cars, that might give us plenty of headaches, but the other major factor necessary for a continuing highway construction program is manpower.

There will undoubtedly be a manpower shortage in the vicinity of the major defense construction areas. However, I believe that the highway contractors of Texas can and will supply the necessary manpower to build our highways.

The labor cost per mile of highway will of course increase, because the productivity of labor will decrease rapidly as we get near the bottom of the manpower barrel.

I believe it would be appropriate at this point to say that the taxpayers of this state are getting a real bargain in the highways we are building today.

Many of you do not realize what a remarkable job the construction industry has done in holding down construction costs, in spite of the fact that the prices of nearly all materials and labor incorporated in construction have risen considerably, and I believe that we can say that the intense competition within the industry is responsible for this. I know that my firm suffered losses on three highway projects completed last year, and I am certain that many others had similar experiences.

We knew that we were bidding the jobs on a close margin, and that with just one bad break we would have a loss, but we were trying to hold together a going, efficient construction organization in order that it would be for an expanded construction program.

The composite mile-price index for federal-aid highway construction computed by the Bureau of Public Roads, in which the base period of 1925-29 has a composite mile index of 100, shows that highway construction costs reached an all-time high in the fourth quarter of 1948, when we had a composite mile index of 165.3.

However, from the end of 1948 to the middle of 1950, the composite mile index took a very rapid drop to a low of 140. The index had risen to 155.7 by January 1, 1951, which is still approximately ten points below the peak year of 1948. The highway engineer and the highway contractor both deserve a lot of credit for what I think is an enviable cost record.

However, we must realistically face the facts and it is inevitable that in the face of material shortages, increased material costs, increased labor costs, and increased taxes that the composite mile index will continue to rise for many months to come and will probably reach a new high during 1951.

Mr. Millard F. Caldwell, civilian defense administrator of this nation, made the following statement to the general convention session of the Associated General Contractors of America in Boston on February 27:

"The Russians, if they so desire, have the planes, the bombs, and the ability to drop twelve atomic bombs on selected cities of this country today, and there is nothing that we could do to stop them."

I am not repeating this statement in order to scare you, as I have no sympathy for scare psychology. However, I do think that it is appropriate in bringing to our attention the fact that it is within the realm of possibility that a great catastrophe or war emergency could strike suddenly, even today, and that in the face of such a possibility, an appropriate termination clause which would operate to provide a reasonable measure of protection to both the state and the contractor should be inserted in all future proposals and contracts.

There has been a great deal of misunderstanding about what is meant by a termination clause. The contractor is not asking, or looking for an "out," whereby he could get released from an unprofitable contract. We are not asking for a one-sided termination clause, but what we do want is a termination clause that would provide for a legal termination of a contract, if conditions arose due to war emergency, whereby it would be advantageous to the state and to the contractor to terminate the contract.

The Bureau of Public Roads and the joint committee of the

AGC and the AASHO have both sanctioned the use of appropriate termination clauses, and the states of Missouri, California, Kansas, Ohio, Oklahoma, and Indiana are now putting termination clauses in their state highway contracts.

It will interest you to know that the Highway Division of the Associated General Contractors of America unanimously opposed the use of escalator clauses, with the exception of freight escalator clauses, in highway contracts.

The first argument of the AGC in promoting the contract method of construction has long been "guaranteed costs," and we consider that the foremost duty of the contractor is to calculate the risks involved and guarantee the costs to the owner, with the exception of freight rates.

Before concluding, I would like to summarize the problems that you as highway engineers and we as highway contractors face today:

1. There will be a critical shortage of structural steel for at least eighteen months, and unless the NPA will allocate sufficient steel tonnage to the Bureau of Public Roads for highway construction, we must face deferment of projects containing structural steel.

2. There will be very little new construction equipment available to the highway contractor during the next year, but if repair parts are obtainable, the highway contractors have ample equipment on hand to efficiently construct a continuing, or even an expanded, highway construction program.

3. Sufficient manpower should be available except in some defense areas, but productivity will decrease.

4. The cost of our highways will increase, because of material shortages, increased labor costs, increased material costs, and increased taxes.

5. A termination clause which would provide a reasonable measure of protection to both the state and the contractor in the event of a war emergency should be inserted in our highway construction contracts.

These problems at hand are not insurmountable, and if we will attack them realistically and expeditiously, instead of sitting by the wayside bemoaning our fate, I am confident that the highway construction program in Texas can and will continue its enviable record of accomplishment.

* * *

Making Better Use of Existing Highways

M. V. GREER
Supervising Traffic Engineer
Traffic Services Division
TEXAS HIGHWAY DEPARTMENT

Making the best of what you have is certainly no new philosophy of human endeavor. It is a doctrine that few engineers, especially those in public service, have been able to escape in their private lives, and they should feel right at home when they are faced with the same doctrine in their professional lives.

In our endeavor to provide an efficient system of highways for automotive transportation, however, our reasoning is torn between a desire for the ideal and that which is economically possible. Certainly there are few, if any, engineers who would not desire to replace every highway of obsolete design on the State Highway System with highways adequate to meet the needs of modern day, high volume, high speed traffic. This we cannot do.

Even the most optimistic road construction program for which we can hope, if freed from the shackles of war production restrictions, will hardly scratch the surface of needed new facilities. The national system of interstate highways, which will no doubt be the first highway mileage to approach the ideal design standards typified by the expressway. comprises only an estimated one per cent of the total road mileage,[1] will handle only twenty per cent of the total traffic,[2] and will involve the expenditure of an estimated

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[1] Traffic Engineering Functions and Administrations, Publication No. 100, Public Administration Service, 1313 East Sixtieth Street, Chicago 37, Illinois, p. 24.

[2] Ibid.

$11, 266, 000, 000 to bring it up to desirable standards.[3] This leaves 99 per cent of the remaining miles which must continue, with whatever improvements that can be squeezed from the budget, to handle 80 per cent of the vehicle miles. This 99 per cent of the remaining miles is ours with which to live, and there is no choice other than trying to use them to the fullest possible advantage.

M. V. GREER
Austin, Texas

How then can better use be made of existing highways? This involves a program of (1) application of control measures authorized by law, (2) judicious installation and operation of traffic control devices, (3) maintenance, (4) localized structural changes, (5) assistance to municipalities with local traffic problems, and (6) sound public relations.

Control Measures: Control measures at best are disliked by the average motorist, but there is no choice other than to use them until such time that highways are built that do not have so many inherent operational weaknesses. We can do much to lessen the motorists' dislike for such controls, however, by using sound judgment in applying only those that will facilitate rather than obstruct the use of the roadway, by basing controls on facts and not opinions, by applying controls that are reasonable, and by explaining the need for any restrictive control that is not readily apparent.

Control measures are many and varied, and other than stop intersections, which are already widely used, the two which seem to offer the prospect of highest returns for the effort expended, insofar as the Highway Department is concerned, are speed control and parking regulations.

A well rounded and intelligently applied speed control program should accomplish these objectives: (1) a guide to traffic for those locations or sections of highway which require a reduction of speed for safe operation, (2) increased capacity of roadway through encouraging more motorists to drive in the same speed range, (3) an aid to the enforcement officer, and (4) a reduction of accidents at locations where speed "too fast for conditions" is a contributing factor.

None of these objectives can be realized, however, unless the mistakes so frequently made in the application of speed restrictions are avoided. A speed limit based on an arbitrary opinion rather than facts and which does not reflect the desires of the motorist is doomed to failure. Too many arbitrary and unreasonably low speed limits are invoked by the weight of public pressure under the guise of the much abused term of "safety." This point is well supported by the statement made by Mr. C. C. Wiley, professor of Highway Engineering, University of Illinois, in his talk on "What About Speed Limits?" at the Twenty-first Annual Meeting of the Institute of Traffic Engineers held in New York in September, 1950: "Defective (accident) reporting is perhaps our greatest present trouble and this results largely from an ill-chosen list of alleged causes. The worst offender is 'too fast for conditions.' The careless and indiscriminate use of this term has caused lots of grief for it has probably been the biggest factor in establishing the popular fallacy that high speed is the root of all evil. The truth of the matter is that 'too fast for conditions' has been made the dumping ground for all cases that seem indefinite or complicated. It is the lazy man's delight and the incompetent man's protection."[4]

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[3] McDonald, Thomas H., "Relation of the Highway Program to the National Economy," 36th Annual Meeting American Association of State Highway Officials, Miami, Florida, December 4, 1950.

There never has been and never will be adequate enforcement to make unreasonably low speed limits effective, and the greatest degree of good can be realized only from speed zones that are reasonable enough to be largely self-enforcing and that will encourage more motorists to drive in the same speed range. If such ends are realized, the capacity of the roadway will be increased, and the hazards of overtaking and passing in congested areas will be minimized. The procedures of the Highway Department, which are based primarily on the principle that any speed which will include 85 per cent of the motorists is reasonable and prudent, are designed toward this end.

The Highway Department can point with a great degree of pride to the progress that has been made within the past two years with the program of marking curves with safe speed indications, but there is still much room for improvement. There has been too much variation from the procedure which was designed to produce a state-wide uniform practice, and many curves have been arbitrarily marked with speeds too low to command the respect of motorists It would be well to check all curves that have been marked and make sure that the values shown are the highest possible that a motorist can travel around them without an uncomfortable side throw and still stay in his own lane.

The legal authority to establish parking regulations except on bridges is relatively new to the Highway Department, and its potential value has probably not been realized. Although it is true that the need for parking regulations on rural highways is not as pressing as in cities, properly signed parking restrictions in front of many roadside business establishments and on heavily congested highway approaches to urban areas will contribute to more efficient use of the highways.

Parking restrictions adjacent to

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[4] Wiley, C. C., "What About Speed Limits?" 1950 Proceedings, Institute of Traffic Engineers.

roadside establishments will make a contribution in the reduction of accidents by removing sight distance obstructions imposed by parked vehicles, while parking restrictions on heavily congested highway approaches to cities will not only provide street space sorely needed for moving traffic but should also serve to reduce losses due to collisions between moving traffic and vehicles maneuvering in and out of parking spaces.

Traffic Control Devices: Traffic control devices are an immeasurable help in making better use of our existing highways if properly designed, properly applied, and properly maintained. They are a necessary adjunct to highways of functionally inadequate design, and they must be seen in the proper perspective before their value can be rightfully appraised.

Consider the STOP sign and ordinary fixed-time (stop and go) signal which serve the function of assigning right-of-way to traffic, the STOP sign usually to one street, and the signal alternately to one street and then to the other. In one sense of the word they are substitutes, and poor ones, for the ideal functional design of a grade separation which would provide for continuous movement of cross traffic. The center line on two lane or four lane undivided pavements is the most commonly used device for separating opposing flows of high speed traffic, a function which is served by positive barriers and median islands in the ideal design of divided highways. The barrier stripe for no-passing zones has no counterpart in the ideal type of divided highway design where there is always a second lane for overtaking and passing, but it is designed for the purpose of restraining impatient and over anxious motorists from overtaking and passing in areas of restricted sight distance. This comparison of the functions of traffic control devices on the usual two lane highway design with their counterparts in the ideal type of highway design is intended only to emphasize their importance.

Based on the functions they serve, why then is not the same study, thought, and supervision given to the use of traffic control devices that is given to the design and construction of new facilities? Every new construction job is under the direct supervision of a registered professional engineer, but how many traffic control devices are designed and installed under such direct supervision? Every traffic control device installed affects every user of that highway, and far too often it is a hindrance and not a help to a motorist. Too many STOP signs and signals have as their only excuse for being, a sour stomach, a bad night's sleep, or a wife's tongue lashing before some official or local bellwether of the community left home for the office and almost got run over at an intersection because he was too busy thinking of his own woes to pay any attention to his driving.

When more attention is given to installation of traffic control devices on a sound factual basis, the motorist will make better use of existing highways, and the so-called "red lights" will turn to green.

Maintenance: Good maintenance is as important to making better use of existing highways as a good line is to a football team. Too often though they both get buried in the mud and someone else gets the praise. There is nothing glamorous about patching a hole in the pavement or fighting a losing battle with a worn out highway that should have been replaced years ago. If the maintenance man can see his job in the broader perspective of helping some motorist to reach his destination safely with a smoother ride and a feeling of higher respect for the Highway Department, he can derive a greater feeling of satisfaction from his job.

There is more to maintenance in helping a motorist get a higher return in transportation values from a highway than merely patching a hole in the pavement. A stabilized shoulder can work wonders in increasing the effective lane width of a narrow pavement and in instilling a feeling of security in a motorist.

A seal coat job done well can remove one of the poorest public relations advertisements on highways today - the warning sign SLICK WHEN WET. Even though it is not a credit, it may be excusable to use such a sign temporarily, but there is not even an excuse for such a sign to remain in place year after year.

A few feet of extra sight distance at an intersection, which may be provided by trimming the lower branches of trees, may one day save a life. Tree trimming can and has been carried further to provide additional sight distance on the inside of curves. In some cases it involved obtaining permission from abutting property owners, but it was worth the price. Every time the need for a barrier line is eliminated, the capacity of that section of highway is increased by virtue of providing an opportunity for overtaking and passing slow moving vehicles.

Mowing that keeps traffic signs uncovered and in full view of the motorist is a distinct contribution to safer use of the highways. When men, money, and machines are scarce, and the rains come and the grass is high, would it not be better to mow more miles to a point just beyond the traffic signs than to mow fewer miles from fence to fence?

These are just a few of Maintenance's contributions to better use of highways, and even though they may never enjoy the spotlight of the expressway, they have the gratitude of the motorist.

Structural Changes: When Maintenance funds have been stretched to their elastic limit, and the good that has been done for inadequate highways is still not enough to handle the traffic load, the next logical step is to resort to structural improvements at specific locations or on sections of highways. These improvements might be referred to as capital betterment projects in the form of widening pavements and bridges, resurfacing of pavements, improvements to traffic, as they affect the use of the highways, is often hard to measure in dollars and cents, and perhaps for that reason projects of this nature have been lost in their comparison with new facilities.

There have been some commendable and notable projects involving widening of pavements and bridges and resurfacing of pavements within the past few years such as U. S. 77 between Waxahachie and the Hill County line, U. S. 81 between Itasca and the Johnson County line, U. S. 290 in Harris and Waller Counties, and U. S. 75 between Corsicana and Ennis. The changes in these highways are a revelation, and the net result is an increase in their traffic value to almost the equal of a new highway. On the basis of figures shown in the Highway Capacity Manual, it means that the widening of a pavement from 18 to 24 feet increases the practical capacity of the highway from 30 to 51 per cent, depending upon the proximity of obstructions to the pavement edges. [5]

There is a very fertile field to explore in relatively inexpensive projects involving improvement of sight distances by cutting back embankments and channelizing intersections. There are a lot of Wye intersections in this state that would make a good starting point. Of all intersection designs, the Wye is not only the hardest on which to control traffic but it creates a guessing game between motorists that requires the skill of a broken field runner to get through without getting hit. Why not bring the conflicting traffic on one of the highways into the other highway at right angles? Such design, with proper channelization, will eliminate the guessing game between motorists by clearly defining the paths of conflicting traffic; it will provide better sight distance in both directions along the intersected highway; and it will make the "stop" regulations more nearly self-enforcing. There are also intersections of other types having a large acreage of paved area that create a guessing game between motorists. They too might well be channelized to reduce the possible area of conflict and clearly define the paths of motorists.

Anything that can be done to eliminate indecision on the part of motorists is a definite contribution to the better use of existing highways, and a well-channelized intersection will quite frequently handle a larger volume of traffic with less delay than a more restrictive type of traffic control device.

Assistance to Municipalities With Local Traffic Problems: The measures that have been discussed thus far have been directed toward making better use of highways that are the sole responsibility of the Highway Department. There are vital connecting links of the Highway System, however, lying within the limits of municipalities that need the same attention. Admittedly, the responsibility for control of traffic on highways within the corporate limits of a city are the responsibility of the city, but regardless of the legal responsibility, the delay and hazards to highway traffic still exist.

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[5] Committee on Highway Capacity, Department of Traffic and Operation, Highway Research Board, Highway Capacity Manual, U.S. Department of Commerce, Bureau of Public Roads, (Washington 1950), Table 8, p. 54.

Some cities do not seem to be too concerned with the traffic problems, while others have realized its seriousness but do not know how to solve it. A helping hand to these cities would not only be a service to through traffic but to local traffic as well.

Many cities, especially the smaller ones, could practically solve their problem of traffic congestion by instituting parallel parking on those streets which are too narrow to permit angle parking without interfering with the free movement of traffic. The difference between angle and parallel parking is nine feet of street space, which amounts to one full lane for moving traffic in a business district where speeds are low. Is there any cheaper way to provide nine feet of street width than a city ordinance changing parking from angle to parallel? There will be opposition from merchants, it is true, but the merchant who relies solely for customers on those who can park in the curb spaces in front of his store each day will not be in business very long anyway. Merchants and their clerks should not usurp curb parking spaces that could be used by shoppers, and they should be educated to the fact that the best answer for their prosperity is united action on their part in providing off-street parking space for their customers within a reasonable walking distance of the business district.

Parking regulations should go further than requiring parallel rather than angle parking. Adequate corner restrictions should be marked to relieve the traffic congestion at intersections. Many cities permit parking so close to the intersection that not only do cars block the cross walks but they make turning of cars, to say nothing of truck-tractor units, almost impossible. Whatever the width of a downtown street, intersection capacities where curb parking is permitted are from 43 to 47 per cent below the capacities for similar streets where curb parking is prohibited.[6] To express it another way, the average 40-foot street with no parking in a downtown area can accommodate the same volume of traffic as the average 68-foot street on which parking is permitted.[7]

Too many cities have the erroneous idea that the best way to handle traffic is to stop it, and this they have attempted to do by installing what they usually refer to as "red lights." Some of these so-called "red lights" have been installed in violation of the Uniform Act, while others were in existence prior to the time the

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[6] Committee on Highway Capacity, Department of Traffic and Operation, Highway Research Board, Highway Capacity Manual, U.S. Department of Commerce, Bureau of Public Roads, (Washington 1950), p. 78.

[7] Ibid., p. 79.

Uniform Act became effective. If at all possible, the cities should be persuaded to remove those signals that cannot be justified on the basis of traffic requirements and to replace all non-standard equipment with equipment of such design that it can be operated to facilitate rather than hinder the movement of traffic.

Encouraging the cities to use their authority to raise the 30 mile per hour speed limit to a value that is reasonable on sections of highways within their corporate limits that are rural in nature will promote respect from the motorist for speed regulations if it does nothing else.

These are just a few things that would help to relieve the traffic bottlenecks in municipalities, and although there will be cases where all efforts to help cities will prove futile, there are other cases where the results will be gratifying.

Public Relations: When all is said and done, the success of any traffic program depends upon its acceptance by the public. Many excellent traffic plans are gathering dust on the shelf because of failure to gain public acceptance. It follows, therefore, that it is just as important for public officials to sell their traffic plans to the public as it is for them to know what should be done about the problem itself.

A number of the measures which have been suggested for making better use of existing highways involve regulations and restrictive controls. These regulations and controls in most cases cannot be enforced on people but must be accepted by them, and acceptance is very unlikely unless the meaning and purpose of such controls are understood. In this respect it might be well to follow the example of the Negro preacher who explained his idea of the art of preaching: "First I tells them what I'm goin' to tell them. Then I tells them. And then I tells them what I've told them."[8]

If you tell people the meaning and purpose of your traffic improvements plan, the chances are highly in favor of your being able to get along with them, and "getting along with folks"[9] is Public Relations reduced to its simplest form.

Summary: Regardless of what the future may hold in the way of new construction, there will always be a big job to be done in making better use of existing highways through application of control measures, judicious use of traffic control devices, good maintenance, localized structural changes, assistance to municipalities with local traffic problems, and sound public relations.

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[8] Darr, John W., "The Public Relations Job of the Traffic Engineer," 1948 Proceedings, Institute of Traffic Engineers, p. 58.

[9] Ibid., p. 53.

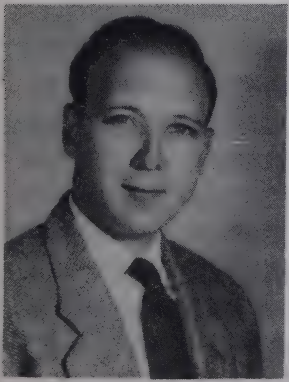
Common Sense Application of GEOLOGY IN HIGHWAY DEVELOPMENT

HUBERT A. HENRY, *Research Assistant*
Road Design Division
TEXAS HIGHWAY DEPARTMENT

Personnel of the Road Design Division became interested in the study of engineering geology three or four years ago, largely as a result of field surveys made at that time. Data from these surveys indicated a rather consistent relation between pavement behavior and geologic units in certain parts of the state. It also appeared that knowledge of geology, whether acquired through experience or through formal education, could be very helpful in locating flexible base materials. As a consequence, two graduate geologists were employed by the Design Division to assist the field in any phase of highway engineering to which geology is applicable.

Although geology had been generally accepted as an aid to the engineer, it was necessary first to determine which of its phases would be of greatest benefit to the engineer in the field and to organize the research group for this purpose. The geologists were made available for lectures in elementary geology and began preparing generalized district geologic reports and maps. Their work was also applied to the investigation of ground water problems, correlation of surface geology along proposed routes, and correlation of subsurface geology at foundation drilling sites.

Further application revealed that the greatest service to the field could be rendered by helping those responsible for locating flexible base materials. Consequently, in the past year more time has been allocated to this phase of the program and a generalized procedure has been established for locating base materials.


HUBERT A. HENRY
Austin, Texas

A typical base material search participated in by the Road Design Division is comprised of six phases. These phases are: (1) a request from the field for assistance, (2) preliminary preparation, (3) reconnaissance field investigation, (4) detailed office study, (5) detailed field investigation, and (6) a report on the results of the first five phases.

As a rule the Design Division does not participate in a material survey without a specific request from the field. A written request is preferred for reference; however, requests are received through the division field design engineers and from field personnel during visits to the Austin office. To facilitate planning, the request should give the location of the job, type and quantity of material needed, and the time available for locating sites. Any additional information that might be of value in the preliminary preparation for the investigation should be included.

The control area for which preparation is made is determined by the project type, project length, and maximum haul distance allowable. Obviously the project type is the major factor in all determinations.

The control area and the geologic section contained within this area are plotted on a planning survey county map (scale: 1"= 2 miles). The geologic units which are probably material sources are then determined. A close study of applicable literature, and aerial photographs when available, is made with these units in mind. For this purpose the Road Design Division maintains a library containing all available bulletins published by the University of Texas Bureau of Economic Geology and many other pertinent publications. Literature on the area or county under study occasionally is not available, and regional or neighboring county literature must be consulted for information on the favorable geologic units.

Through this study a general working knowledge of the aerial geology is gained and the geologist is ready to make the field reconnaissance.

The first step in this phase is the contacting of the office of the resident engineer. The personnel responsible for locating material are consulted as to known past and proposed sources. The proposed route is inspected, usually with some person from the residency, and all pertinent information such as prospective haul roads, topography, geologic outcrops, and other physical characteristics is noted.

The area in which geologic observations are made is determined by consulting the available literature. It is possible that reconnaissance may begin in a neighboring county in which geologic units under study are better exposed or have been previously described and measured. This regional information can be extrapolated and applied to the desired area. Of course, if there is literature of more local nature the regional approach is not necessary.

To illustrate the occasional necessity of the regional approach and the misconception which it often causes among engineers throughout the nation, the following quotation is used. It is from a paper entitled The Background of Engineering Geology, presented by Mr. C. E. Erdman to the Seminar on Engineering Geology held by the U. S. Geological Survey, Denver, Colorado, in 1946:

"Frequently the construction area may be so restricted that it cannot be said to have truly geologic dimensions. Hence, the methods peculiar to the geologist cannot be employed unless he works beyond its limits. Reference to previous work in the region often furnishes the necessary information. Sometimes it is necessary to seek the key to certain geologic phenomena miles from the locality where the knowledge gained is to be applied. To say the least, this may be disconcerting to an engineer whose chief interest in this world may be compassed by a few hundred or thousands of square yards. When such excursions are necessary, the reasons therefor should be explained fully so that there need be no apprehension that the journey is for purely academic reasons. If possible, take the engineer along."

Figures 1 through 8 illustrate some of the reasons for these excursions, and may be of some benefit in understanding the necessity for them. (The slides from which these figures were made were furnished by Professor A. H. Deen, Chairman of the Department of Geology, and Dr. H. B. Stenzel of the Bureau of Economic Geology, University of Texas.)

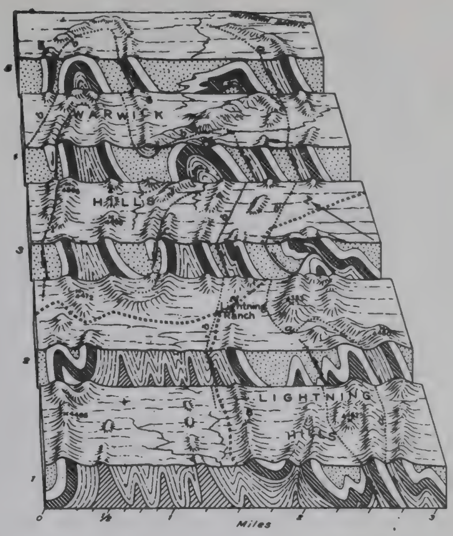


Figure 1

Figure 1 shows in three dimensions the subsurface geologic units and their topographic expression in an area in which a hypothetical road (shown by dashed lines) is to be constructed. The area also will be hypothetical as used here.

These five blocks if placed together would give the topographic picture as shown on relief maps. Set apart as they are, they show the position of the subsurface strata as it was interpreted from surface evidence.

Preliminary study of the literature on the area would give information on the history of the structural conditions. For example, the folding shown in this photograph would be described as that caused by extreme lateral pressures in the earth's crust. The geologist should have a fair mental picture of the geologic structure before he starts his reconnaissance.

For purposes of this discussion we will suppose the parent geologic material shown here is obliterated by soil development. The first thing the geologist does in searching for material is visit an exposure of the geologic section most likely to contain a usable base material. Good exposures are listed in the literature and we will suppose that there is one in the creek located near the center of block four. This exposure reveals good road material in the unit shown by the heavy diagonal lines. The hard, resistant beds of the potential road material hold up the ridges, and these ridges are traceable on the aerial photographs with the stereoscope. These beds, or ridges, are also delineated on the geologic map. With the aid of maps or photographs, or both, the geologist can trace the key beds, and possibly trace them to a desirable quarry site. The potential quarry sites constitute the field area of concentration where, if there are no natural exposures, test holes can be dug to explore the subsurface and make quantity estimates.

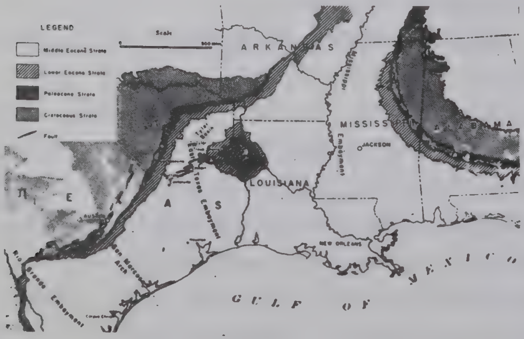


Figure 2

Figure 2 illustrates how beds can outcrop in an area and then dip into the subsurface and remain continuous until brought to the surface by earth movements a hundred miles away. It also illustrates how they are shown on the geologic map.

The beds designated by the diagonal pattern are of the Wilcox group. The stippled area represents beds of Carrizo formation.

The Wilcox beds were laid down along the old lower Eocene coast line and the Carrizo beds were deposited over them during middle Eocene time. A subsequent domal uplift in this area placed the beds in position for erosion to remove the overlying Carrizo and again exposed the Wilcox.

As a consequence of the uplift, the structural basin known as the Tyler Basin was formed, and the repeated presence of the Wilcox on both sides of the basin is evidence that it is continuous through the subsurface.

Figures 3 and 4 show the similarity of the Wilcox as it crops out on each side of the basin. One exposure (Figure 3) is near Troup and one (Figure 4) near Athens.

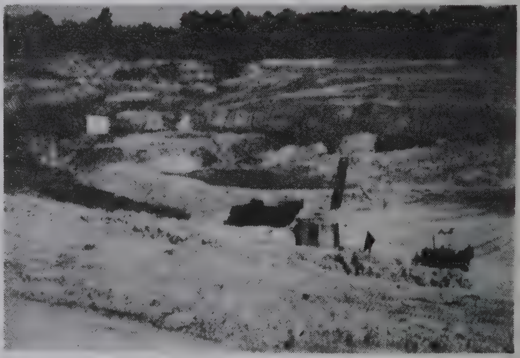


Figure 3

Figure 3 pictures the Wilcox-Carrizo contact in a clay pit near Troup. Clays of commercial quantity and type are being produced here from the Wilcox formation.

Figure 4

Figure 4 shows the same situation, the Wilcox-Carrizo contact, in a clay pit near Athens. Although the exposures are almost a hundred miles apart, the formation still contains clays that can be produced commercially, and are essentially the same mineralogically at both localities.

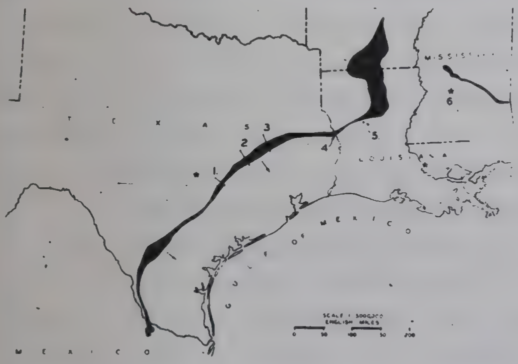


Figure 5

The aerial outcrop of the Yegua formation is shown in Figure 5 as it strikes northeast-southwest across the state. There is not much good road building material in this formation. However, the Weches formation lies parallel to, north and west of, the Yegua, and a great quantity of iron ore sands and gravels have been taken from it for road construction. To illustrate how the Weches formation can be traced as it extends across the state from near Floresville in South Texas to the Louisiana border, outcrops have been photographed at Smithville, Hurricane Shoals on the Trinity River, and in San Augustine.

Figure 6

This exposure shown in Figure 6 is on the south bank of the Colorado River at Smithville.

Figure 7

One hundred and fifty to two hundred miles northeast on the Trinity River at Hurricane Shoals the formation crops out as pictured in Figure 7. The material is about the same; perhaps a little more iron ore is present.

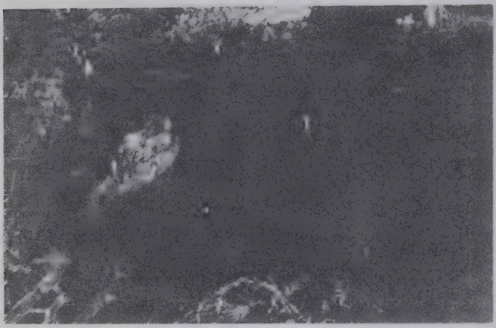


Figure 8

One hundred and fifty to two hundred miles farther to the northeast in a cut on Planters Street in San Augustine the same unit is exposed with higher content of iron ore (Figure 8).

Office Study - This phase begins with compilation and study of reconnaissance data. This data is correlated with the aerial photographs, following which the reference map is corrected if it is inaccurate or lacking information in the control area.

A second recourse to the literature results in covering most of the information on the proposed geologic unit. The geology libraries of the University of Texas, State Board of Water Engineers, Railroad Commission, and U.S. Geological Survey (Ground Water Division) are available for this use. Geologists with these several organizations who may be specialists in the region under study are consulted.

Detailed field investigation - This work is confined almost entirely to the control area and the prospective material sources within it. Pertinent outcrops are studied, and sketch geologic maps of each potential material site are made. The use of a core drill is especially valuable at this point, as more accurate quantity and quality estimates can be made. The economic factors of the prospective sites are then compared and weighed.

When tentative sites are determined it is usual to go to these sites with the Resident Engineer or his representative and make final inspections in light of the residency's needs and opinions. Quantity estimates are made by measuring exposures at the site and using driller's logs, if a core drill has been used.

The report - The report includes the geologic age of the material source, the site location and approximate haul distance from the center of the project, quantity estimates of stripping and usable material, and speculation as to possible quarrying methods and the effect of excavation upon nearby drainage systems.

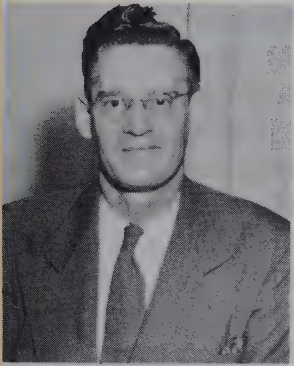
A large scale map showing the outcrop pattern of the source unit, the site location, and pertinent culture. is traced from aerial photographs of the area. If photographs are not available, all information is submitted on a Planning Survey county map.

The submission of this report to the district usually ends the participation of the Road Design Division in the material search.

Experience in Construction and Maintenance of

Highway-Railroad Grade Crossings

B. M. STEPHENS JR.
Assistant Chief Engineer
T & N O Railroad Company



B. M. STEPHENS JR.
Houston, Texas

I have been asked to speak on the subject of experience in construction and maintenance of highway-railway grade crossings.

This is a pretty broad subject, a subject upon which a railroad construction and maintenance engineer of only some 25 years of experience might have some justifiable difficulty in developing properly. However, with able assistance from my many friends in the railroad engineering brotherhood, I shall take a crack at trying to present some data which, I hope, will be of interest to this gathering.

Figures and statistics, I know, tend to be rather boring when included in a speech, but to get started on what I want to say, the quoting of some figures and statistics seems to be necessary.

In this great state of ours, there are approximately 17,400 miles of Class One main and branch line railroad. Crossing over this mileage of railroad is a total of 14, 177 state and federal highways, farm-to-market roads, county roads, and city streets, which makes, speaking in averages, approximately one crossing per 1.2 miles of track.

Of this grand total of highway-railway crossings, only the pitifully small number of 778, or some 5.5 per cent of the total, are at separated grades. The division in types of structures is 263 overpasses and 515 underpasses. This leaves a balance of 13, 399 crossings, about 94.5 per cent of the total, at grade, a great many of which pass over high speed, heavy traffic main and branch line trackage.

Going a little further into the figures, only 1, 348 of the 13, 399 grade crossings are protected by special types of protection such as automatic crossing gates, crossing watchmen, visible and audible automatic signals, and audible only automatic signals. This represents very slightly more than 10 per cent of the total number of grade crossings. The balance of 90 per cent, or 12, 051 crossings, are protected only by standard ordinary or reflectorized crossbuck signs.

Please bear in mind that the figures quoted, secured from my railroad colleagues, do not represent the state's entire highway-railway grade crossing picture as they cover only the eleven major lines of railroad operating in Texas. Nothing is included to cover the situation involving the several short line railroads in the state.

There may be some wonder as to why there is such a relatively small number of grade crossings not now specially protected and why there is not a concerted and complete program underway to provide such protection for all grade crossings.

The answer to this is, considering that the most inexpensive type of automatic protection, namely, automatic flasher light signals, averages about $6,000 in cost per installation, it would take the staggering sum of about $72,300,000 to provide protection for the 12, 000-odd crossings not now specially protected.

When it is mentioned that the normal type of grade separation structure, overpass or underpass, now required by essentials of highway design usually costs from $250,000 to $500,000, it can readily be seen why there is not a wholesale building of underpasses and overpasses.

As to the type of construction, the 13, 399 crossings at grade range from just plain dirt to ordinary road gravel, asphalt topping, combination asphalt topping and flange plank, full timber planking, and concrete slab --please understand that this listing is not in particular order of preference--with all of which types of crossing every railroad in Texas has had at least a modicum of experience.

The construction and maintenance of 13, 399 crossings, and the total is being added to almost daily, represents a considerable amount of money, not to mention the many headaches that go along with grade crossings, such as crossing accidents, complaints about riding conditions, frequency of crossing blocking by train movements, obscured vision, sharp and steep approaches, and hazards to train operations from roadway construction and maintenance materials and other objects being left unthinkingly on the track by roadway maintenance men and others.

On the construction side, forgetting about dirt and gravel crossings as such crossings are not satisfactory under present types and volumes of highway traffic, the average cost per running foot of highway-railway track paving, nine feet wide, or between ends of ties, runs to about $21.50 for asphalt topping, $34.40 for combination asphalt topping and flange plank, $45.50 for full timber planking, and $67.40 for concrete slab.

On the basis of such unit costs, assuming roadway pavement width at the point of crossing to be about 30 feet, although many crossings have roadway widths in excess of 30 feet, the initial investment in an improved type of crossing represents an expenditure in the neighborhood of four figures to the left of the decimal point.

Let us say, and I think this will be on the conservative side, that some 50 per cent, or about 6,700, of the existing grade crossings are of some kind of improved type and that the average width is 30 feet.

Let us also say, again on the conservative side, I would think, that the average cost of the improved type of crossing approaches $35 per running foot, nine feet wide. The initial investment to the railroads, then, for the 6,700 crossings at $35 per running foot amounts to over $7,000,000.

But the initial investment is not all. Once the railroads build a grade crossing, they are pretty nearly always stuck with it for a substantial number of years. This means that a considerable sum of money must be spent for maintenance, year after year.

Unfortunately, records of maintenance expenditures are not kept in such a fashion as to permit the development of specific cost data relative to crossing maintenance. Based on years of experience, however, railroad maintenance men are pretty generally agreed that average annual cost of maintaining grade crossings, taking into account all factors relating to type of construction, volume of rail and highway traffic, and other such things, amounts to about $75 per crossing.

Average annual cost per crossing to maintain special grade crossing protection is agreed to be in the neighborhood of $260 per crossing and average annual cost of maintaining underpass structures is estimated to amount to about $250 per structure.

Based on such averages, annual cost of maintaining 13,399 grade crossings would therefore approximate $1,005,000. Special crossing protection will add an average annual cost of about $350,000. Underpass maintenance will increase the maintenance bill by an annual average amount of about $130,000.

An interesting side light to the maintenance and construction picture is that, based on experience of the past three or four years, the average annual cost per railroad for new grade crossings or complete reconstruction of existing grade crossings has amounted to approximately $3,500, a new crossing expense to the eleven railroads of some $355,000 per year.

There have been a great many words written about the merits and demerits of various types of grade crossing construction, and the railroads, individually and collectively, have undertaken a substantial amount of research for the purpose of developing satisfactory types of crossings to meet the demands of all kinds of railroad and highway traffic.

Tests have been made on such types of construction as combination asphalt topping and flange plank, full timber planking, cast-in-place concrete slab, precast concrete sectional slabs, cast iron and steel crossing plates, prefabricated sectional timber planking, and nested rail sections laid between running rails, to mention the most generally used types of crossings.

From these tests, the railroads and organizations of railroad engineers and maintenance men, such as American Railway Engineering Association and Roadmasters and Maintenance of Way Association, have developed workable specifications applying to the best possible construction of various types of crossing.

From time to time, as experience dictates, certain changes in specifications and in details of construction are made to improve the different types of construction.

Experiments have been carried out as to different methods of preparing railroad subgrade in such manner as to eliminate drainage difficulties as far as possible, and to reduce to a minimum resurfacing and lining of track at point of crossing.

Different species of wood and kinds of preservative treatment have been tried out to determine the best kind of treatment and the most lasting species of wood under the requirements of traffic.

All of these things have resulted in the standardization of crossing construction to a great extent, thereby making it possible to get a little further along the road to completely satisfactory grade crossings, regardless of type and regardless of demands of traffic.

Greater effort is being made to educate railroad maintenance forces in the matter of properly maintaining whatever type of construction it is necessary to maintain. I believe that I am safe in saying that considerable progress along this latter line is being made.

Also, as one of the most important factors in proper and satisfactory maintenance of grade crossings, we are urging our field supervisors and section foremen to increase their contacts and become better acquainted with Highway Department maintenance people and their problems. We hope we are accomplishing something along this line.

Recently, the Bridge Division and my company have been giving serious study to a new type of highway-railway crossing. This type of crossing, tentatively estimated at a cost per running foot of $48.50, is a departure from formerly accepted designs in that the crossing utilizes steel grating of Irving Subway type as the wearing surface.

From a strictly theoretical standpoint, the steel grating crossing appears to have a great many points in its favor. On the practical side, however, there is very little evidence at hand as to the behavior of such a type of crossing under a combination of rail and highway traffic.

Although steel subway grating has been used successfully in quite a few cases for highway bridge decking, I know of only one instance where a steel grating highway-railway crossing has been installed. Unfortunately, this crossing has not been in service for a length of time sufficient to permit development of any great amount of data either for or against it.

Summing up, I think I can safely say that preponderating opinion in railroad construction and maintenance engineering circles is to the effect that the full timber planking crossing is the best higher type of crossing so far developed for any and all classes of rail and highway traffic.

The opinion extends further, however, to the effect that the combination asphalt topping and flange plank crossing, if properly constructed and maintained, is almost the equal of the timber planking crossing and, particularly, is ideally suited for use in connection with grade crossings of tracks by city streets, county roads, and secondary and farm-to-market roads, which roadways are generally of somewhat lower standard of construction than federal and state primary highways.

It is pretty well generally accepted now that automatic crossing gates and standard flasher light signals are about the most effective of the half-dozen or so types of special crossing protection presently available.

Automatic crossing gates are particularly effective for divided lane roadways and are almost a "must" installation for crossings over double main tracks.

For single track crossings and roadways of two or three lanes, the standard flasher light assembly appears to do an excellent job and seems to be all that is required.

The old style bell and wigwag signals, while not particularly suited for heavy traffic crossing, are still very much in evidence over the state and seem to be doing a respectable job on light traffic highways.

Manually operated gates and crossing watchmen, unless kept in service around the clock, do not appear to furnish the full measure of protection that is furnished by automatic devices.

Our biggest difficulty with all kinds of special crossing protection is the tendency of some vehicle drivers to ignore crossing warning signals. This may be possible of correction in some measure by an educational program, but in many cases, it is probably going to take a bit of stiff law enforcement to secure good observance of the warnings given by the signals.

In closing, let me say that I do not believe that the relationship between the Highway Department and the railroads has ever been on a higher plane, and speaking for myself as well as for my railroad engineering colleagues, there doesn't seem to be any reason why such relationship cannot continue.

* * *

Highlights of . . .
Motor Vehicle Operations

E. J. AMEY, *Director*
MOTOR VEHICLE DIVISION
TEXAS HIGHWAY DEPARTMENT

The major functions of the Motor Vehicle Division are the administration of the motor vehicle registration, Certificate of Title and Reciprocity Statutes and this includes the handling of motor vehicle registrations, the issuance of Certificates of Title, and the execution of reciprocal agreements on motor vehicle operations with other states and countries.

Registration: Every vehicle as defined by the statutes must be registered. This includes all types of passenger cars, commercial vehicles, buses, house trailers and motorcycles. An attempt was recently made to require the registration of building and maintenance machinery as vehicles, but this has been deferred pending the outcome of a court trial. For each vehicle registered, yearly license plates and registration receipts must be issued. The Highway Department administers the registration laws through 254 County Tax Collectors who act as designated agents. Under the law these Tax Collectors are required to report each Monday all the registration transactions of the previous week.

The function of license plates is to identify the vehicle and to collect the fee imposed by the Legislature. The registration year is from April 1 to the following March 31, and the plates go on sale February 1. The order for manufacturing each year's plates must be placed eighteen months prior to the actual sale of the plates. The manufacture itself is a job comparable to an average construction job in the length of time required, the amount of material used, the cost of the project, and the attendant difficulties. The numbering system which embodies the use of upper and lower control letters and the use of not to exceed four numerals, was adopted in 1945 and enabled us to reduce the size of the plate by approximately 25 per cent and also effect a 25 per cent saving in manufacturing cost. All series of plates are numbered from 10 to 9999 with the exception of one series which is known as the SO or State Official series and which extends from number 1 to 350. The letters G, I, O, and Q are not used because of their similarity to other letters and numerals.

Our number of registrations has grown to such an extent that for the 1952 plates we are revising this numbering system by reserving all upper control letters for passenger cars and on all other series of plates we are using an upper numeral over a lower control letter. By this change we will be able to provide for 6, 803, 190 registrations.

Texas license plates are manufactured by the Texas Prison System and we use 26 gauge sheet steel, cold rolled, since this is the only type of steel upon which we are able to obtain bids. Some years ago we used a blue steel but it was found that embossing under pressure caused an oily substance to appear on the plates resulting in a nonadherence of paint. All plates are size 6 1/2" x 10 1/2" with colors of black and gold alternating each year. Since storage space is at a premium inside the Prison System and since it now takes 1, 600 tons of steel to manufacture one year's plates, we have to plan a schedule whereby the steel comes in monthly or at determined intervals and the finished plates are shipped out in the same manner. One year's production is the equivalent to 26 carloads of plates. You may wonder why we cannot ship the plates direct to the counties as manufactured instead of asking the districts to store them, and this is because each election year approximately 60 new Tax Collectors take office and we do not deem it advisable to place the supply of new plates in the Tax Collector's office until after the new Tax Collector has taken over. Also in counties with large registration, such as Dallas and Harris Counties, they are experiencing difficulty in storing the plates for the one year and would certainly not be able to also provide space for the additional plates. The delivery of license plates to all counties on January 15 is working out very well and I appreciate the co-operation which the districts have given us in this respect. Our plates now cost approximately 10 cents per pair, which includes a 2 cents per pair profit to the Prison System.

E. J. AMEY
Austin, Texas

In the current registration year which extends to March 31, we have already registered over three million vehicles and I estimate that we will register 3, 180, 000 by the time the year has expired. The gross fees collected for 1950 registration will be approximately 49 million dollars of which 41 per cent will be retained by the counties and 59 per cent will be received by the state. This is a reversal of figures of ten years ago when the counties were receiving approximately 60 per cent and the state 40 per cent, and this has been caused by the great increase in registration in each county and the fact that many counties which formerly retained all of the registration fees, now exceed $50, 000 and pay one-half of the amounts over $50, 000 to the state. There are also more counties which exceed the county maximum of $175, 000 after which all the fees are received by the state. The following comparisons of total registrations and total fees will give you some idea as to the increase which has been made.

Total Registration

	1920	430, 377
	1930	1, 401, 748
	1940	1, 802, 063
	1945	1, 713, 944
	1949	2, 784, 480
Est.	1950	3, 100, 000

Total Fees

1930	$ 13, 600, 000
1940	19, 810, 000
1945	22, 183, 000
1949	41, 588, 000

	To County	To State
1930	67.5 %	32.5 %
1940	58.5	41.5
1945	55.2	44.8
1949	43.8	56.2
Est. 1950	41	59

Texas is now fourth in the Nation in registration of motor vehicles. California is first, New York second followed by Pennsylvania and Texas. In the number of commercial vehicles Texas is second, exceeded only by California.

Registration fees collected are affected by underweight registration of commercial vehicles and this condition can be remedied, in our opinion, only by greatly increasing the penalties for overloading and by improved enforcement. For some years we have been troubled by a small number of counties who engage in illegal practices. These consist of trading cedar post, lumber, wire, etc. for registration or for increased weight on commercial vehicles. It is difficult to find these evasions due to the normal large increase of motor vehicles registered in all counties. Our problems have also been aggravated by the desire of many people to evade the ad valorem tax imposed by counties and cities on motor vehicles and to evade parking meter tickets by registering in a county other than that of their residence. There have been numerous cases where county officials of counties in the smaller registration bracket have solicited registrations from motor vehicle owners in the large registration bracket counties.

Counties in Illegal Registration

1938	33
1941	12
1946	15
1947	15
1948	14
1949	17
1950	10

In the past two years we have adopted the policy of demanding a refund from the counties of the amounts which have been determined to be illegal registrations, and we have recovered over $50, 000 resulting in our net losses being considerably reduced.

The personal interest of people in registration is shown by the many requests for low numbers and for certain control letters, which at times represent their name or initials. Fortunately for us we have been able to refer all such requests to the counties. We receive many, many suggestions each year covering proposed use of a slogan on the license plates, suggested colors, etc., and I might say that our present colors are adhered to because they have been proven by scientific test to be both legible and durable. Colors such as maroon, blue, and yellow are not adaptable to Texas weather conditions. It is surprising the interest which is displayed in the state official license plates, which are issued only to elective officials.

Certificate of Title: Most people do not know just what a Certificate of Title is and do not realize that it is comparable to an abstract or deed to a piece of real property. Many times they stuff the title in the car pocket or misplace it not realizing it is important. There are many people interested in titles other than the motor vehicle owners and these people are the individuals and companies who buy or sell vehicles or who loan money on them or who are in the business of insuring motor vehicles.

Although the registration is issued by the County Tax Collector at the time application is made, the Certificate of Title is not. Titles are issued only in the Motor Vehicle Division, and upon application for registration and Certificate of Title, if all papers are in order and the required evidence is present, the Tax Collector accepts same and issues a receipt covering the application for title. This receipt is temporary in nature and allows the operation of the vehicle for a period of ten days pending receipt of the title. Under the law, the Tax Collector is required to submit title applications daily. Unfortunately many counties do not do this, but hold them up until they have what they consider a sufficient number to submit. When applications with supporting evidence are received from the Tax Collector they are checked against the Tax Collector's report as to remittance and commission paid for handling. Then the applications are separated as to make and motor number and each application other than those on new cars, for which manufacturers' certificates are attached, is taken to the filing section and the current title card is attached to the evidence and application. From there the applications go to the title examining section where trained examiners check the application as to correctness. This is not a mechanical check since all types of legal transactions including repossessions, court judgments, wills, and other legal papers must be handled. Throughout the year 9 per cent of all applications received must be returned to the county for corrections of some type. We do not make any correction on any title application, for to change them in any way would mean that when we are called upon to testify in court as we frequently are, we would be unable to state who had made the change. As it is, we know that no changes are made in our office. Upon approval by the title examiners, the title is given a current title number and goes to the dexigraph section where a photostatic reproduction is made of the body of the application and this photostatic negative is in turn rephotographed in a mask to become the finished title.

Applications Received

	1941	399, 699
	1945	630, 688
	1947	1, 148, 367
	1948	1, 417, 924
	1949	1, 491, 982
	1950	1, 829, 945
Jan.	1950	155, 814
Mar.	1950	169, 791
Apr.	1950	172, 656
Oct.	1950	139, 231

The applications received vary from 3, 000 per day to 16, 529 which were received in one day. For the past year 65 per cent of all applications have had liens. This means that two titles must be issued on such applications. The original title is mailed to the lien holder and the duplicate original is mailed to the owner. The mailing process in itself on ten to twelve thousand titles per day is a considerable job since these must be inserted in envelopes, run through the mailing machine and sorted into bundles for transmission to the Post Office. Titles are issued from five to ten days after the receipt of the application. Our annual postage bill for mailing titles is $50, 000 and this represents titles mailed by third class since we have found that we receive just as good service as we do by mailing them first class and we thereby save approximately $35, 000 per year. An average of 250 titles per day are returned by the Post Office due to people having moved, wrong address shown, or the name of the city abbreviated, or some other reason why delivery is not possible. These returned titles are indexed and we keep them for 90 days after which they are destroyed.

There are many other functions related to the Certificate of Title operations which must be carried on continuously. Other title states forward us notices of Texas titles surrendered to such states and we must abstract these titles from our active files and cancel them. After our applications and evidence are microfilmed, we stamp the titles of other states which have been surrendered to Texas as cancelled titles and return them to the other states in order that they may clear their files. We also issue thousands of assigned motor numbers to new and replacement motors. We receive each week long lists from the city police officials throughout the state covering parking violations and on these we must furnish current registration and title information. We continually receive stop notices on stolen cars from various federal, state, county and city enforcement agencies. In our main filing room we have four telephone lines which are busy answering calls both local and long distance from people wanting information. In 1950 the Motor Vehicle Division wrote 101, 076 letters. Most of these were form letters with certain information filled in, but this amount included 13,787 dictated letters. This is an average of 8,423 per month and 410 per day.

Reciprocity: The purpose of reciprocity, as you know, is to effect a free flow of traffic between states and to assist in the elimination of trade barriers. Reciprocity is valuable to all types of motor vehicle traffic, but is particularly valuable to commercial vehicles since they are able to operate in interstate operations through many states without having to register in any state other than that of legal residence. The Department is authorized under the statutes to enter into reciprocal agreements with other states and countries and we have been able to enter into such agreements with all states. These agreements are not all alike since some states are limited by their laws in the extension of reciprocity to certain types of operations. We have signed agreements with 46 states and a letter agreement with one state and the District of Columbia, since they are not authorized by their statutes to enter into signed agreements. These agreements are usually the result of personal contacts with representatives from the other states or the result of discussions at annual meetings. It is my opinion that reciprocity is particularly valuable to the states in that if they do not enter into reciprocal agreements with each other then we will soon see federal control of motor vehicle operation. The American Association of Motor Vehicle Administrators which is composed of the 48 states, the District of Columbia and the Canadian Provinces, has adopted uniform procedures on reciprocity and suggested uniform agreements.

The Operation of the Motor Vehicle Division:

Personnel by Sections

Accounting	26
Corres. & Microfilm	23
Title Examination	36
Filing	81
Supply	6
Dexigraph & Mail	10
Lic. Plate Mfg.	2
Invest.	7
Administration	10
Total	201

Although we have had a great increase in the volume of work handled, we have had no increase in the total personnel in the last two years and this is attributed to a smaller personnel turnover, a training course, and in the adoption of many mechanical devices which are used in handling the large volume of work. The Motor Vehicle Division has probably more detailed records than any other division in the Highway Department, and yet we have no old records. In 1946 we microfilmed millions of old records which at that time were contained in open racks and shelves, and since that time we have microfilmed title records daily and registration receipts yearly. We have a microfilm library in which there are 21 file cases containing 15,100 rolls of 16 millimeter film, each roll being 100 feet in length.

On this film there are 62 million records and documents. We refer to the film dozens of times each day and we have a small number of girls who are trained in abstracting information quickly and in the care of the film. It is now possible to obtain information from any of the film by interoffice communicators while holding a long distance call, and this provides an improved service to the public as well as to ourselves. In our main file room we have 198 file cases containing 22 million registration receipts and titles. Eight thousand title records go in and out of the title files each day and five thousand registration records are placed in the files each day. Our division now occupies 15,391 square feet of floor space in four different buildings and we need twice as much since our files have increased so rapidly that they are now side by side with no working space in between. Each year we ship over five million registration receipts in triplicate to the counties plus millions of other title and registration forms and supplies. The printing and shipping of plates and supplies in itself grew to such an extent that we now have a small section which does nothing but handle this type of operation.

We have adopted all the mechanical methods which are suitable for handling the enormous volume of detailed work. We have twelve interoffice communication sets, including one in a building a block away where it was necessary to run cable over the adjoining roofs. We use multi-sort machines on which one operator can sort five times as many papers or receipts as were formerly sorted on desk tops. We have found and adopted new adding machines which add not only the money, but the transactions at the same time thereby replacing a cumbersome hand machine operation. We have acquired a mechanical device to count the title application receipts since we must check on the commissions allowed the Tax Collectors. Last year we initiated a procedure which is being repeated this year since it was found to be very beneficial and we placed a man in each of the six counties having the largest registration for the express purpose of assisting the Tax Collector in preparing registration reports during the rush period and performing our accounting checks in the Tax Collector's office. Last year we placed over a million registration receipts in the files 30 days prior to the time required in previous years and during our rush registration period it is important that these receipts get into the file as quickly as possible in order that we may furnish information on same. We have a small force of field investigators whose work consists mainly of checking and prosecuting illegal registration, and much credit is due these men for holding down the illegal registration practices.

The outside contacts which the Motor Vehicle Division must maintain are many and varied and right here I want to apologize for not getting around to the district offices as much as I should like.

Our work requires us to maintain active contact with the following:

1. Two hundred and fifty-four County Tax Assessors-Collectors - each year we hold a number of schools of instruction throughout the state to which all Tax Collectors are urged to come. We also attend annual meetings of the Tax Collectors Association.
2. New and Used Car Dealers Association.
3. Association of Automobile Finance Companies.
4. Texas Banks - which now finance as many motor vehicles as the automobile finance companies.
5. Five Texas trucking associations.
6. Motor Bus Association.
7. The auto wreckers and junk yards.
8. Motor rebuilders.
9. Automobile and truck manufacturers.
10. American Automobile Association.
11. Enforcement agencies
    - City Police
    - Sheriffs
    - State Police
    - National Automobile Theft Bureau
    - Federal Bureau of Investigation
    - Bureau of Narcotics
    - Immigration Bureau
    - Customs

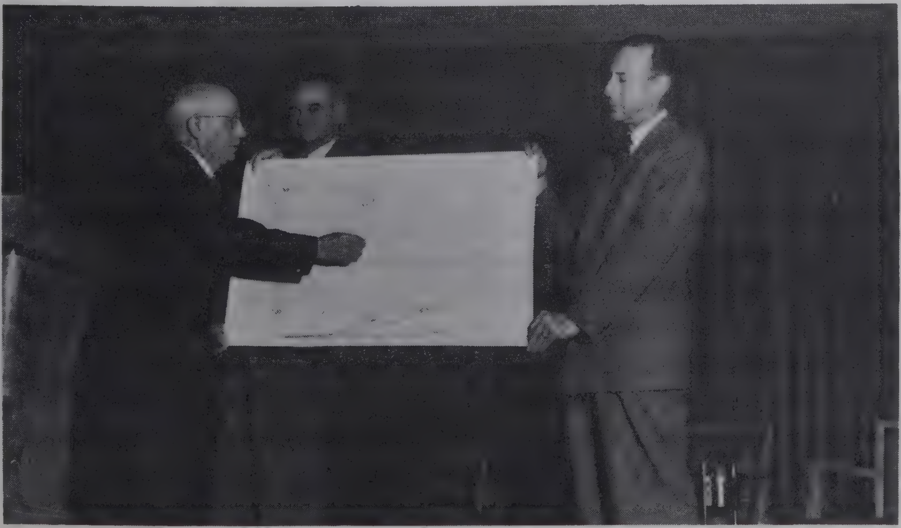
American Association of Motor Vehicle Administrators: The functions of this association deal with registration of motor vehicles, issuance of Certificates of Title, drivers license, financial responsibility, accident records, safety promotion and education, vehicle inspection, safety equipment and enforcement, and reciprocity.

We try to attend the meetings of the above associations and departments in an effort to improve our public relations and too little time is left for visiting in our own highway family.

I appreciate the opportunity of appearing at this meeting and giving you an outline of the work of our division.

* * *

MR. POTTS LIKES GOOD HELP !



Design and Construction

A few years ago when the Highway Commission elected to construct a network of low cost roads or Farm to Market Highways throughout the state, we highway employees were given a very big job to do. The job which I refer to was the designing and constructing of these roads. At the beginning of this program, we were reluctant to design these roads to low standards because it was a complete about-face from what we had done in past years. We all had visions of the low cost roads failing to stand up and were afraid of the criticism that we would get if they did fail. For this reason it took approximately three years for us to lose our fears and get the standards of design down as low as desired by the Austin Office. It required a lot of brow-beating, so to speak, by Mr. Greer, the Land Service Roads Department, and the District Offices to get us in line, but we finally made the transition, and I believe that with all things being considered, we have done a good job. I believe that in most instances, we are getting the best roads that can be constructed with the limited funds allocated for this work. It is my opinion, however, that there is still room for improvement, and my subject for today concerns one of the ways that we can improve these roads.

Before going too deeply into the subject matter of this paper, I would like to say a few words that I hope will dispel any thoughts from your minds that I am advocating the wholesale substitution of dips for bridges on our highways. I believe that bridges should be used wherever possible if the amount of traffic to be handled justifies a bridge and if sufficient funds are available for construction of the bridge. However, I will say that in special instances where the above mentioned conditions are not fully applicable, it would be better to construct a good dip than an inadequate bridge, and that the use of dips on our low type roads should be given due consideration.

JOE M. BINGHAM
Mineral Wells, Texas

Most of us have designed and constructed low-water dips be-

# of Low Water Dips

JOE M. BINGHAM, *Resident Engineer*
TEXAS HIGHWAY DEPARTMENT

cause we did not have the money in the job to build a structure of the usual type. I have seen all of the dips in my own district and a great number in the other districts, and I know that you have seen many of them around over the state. I feel sure that you will agree with me when I say that there are some good ones, some that are just fair, and some that are bad. The bad ones do not always fall in that category for the same reason, but for various reasons too numerous to mention. However, I believe that the chief reason is that we do not give them enough study in the design stage.

Evidently some of us are taking the attitude that our dips are only temporary structures, that they will be replaced with bridges within a year or two, and therefore are not of sufficient importance to warrant a thorough effort on our part. I cannot agree with this line of thought for the following reasons: (1) For reasons of safety any portion of our highways, be it Farm to Market or otherwise, which goes to make up the riding surface on which the public will travel is worthy of our very best engineering effort; (2) The highway pattern has been, and will probably continue to be for more and more miles of low cost roads -- roads that will require all our skill and ingenuity as engineers to assure maximum mileage on a minimum cost-per-mile basis. If this is true, then for financial reasons our dips will generally be permanent instead of temporary structures and will necessarily remain in service for a considerable length of time; (3) Due to the national emergency we are facing today, which we already know will bring shortages of skilled labor and critical materials to the construction field, we may be forced to use more low-water crossings in the future than we have in the years just past; and (4) Through the use of proper design and construction methods, dips can be built that will be adequate for certain types of roads from the standpoint of both traffic and drainage, which are essentially the basic requirements of any highway structure.

My first experience along this line came on a project where an existing dip was left in place to become a part of the completed project. I thought we got a good job on everything except the dip connections or approaches, and this fact alone ruined the job in my estimation. If you attempted to drive across the dip at a speed above twenty-five miles per hour, you were literally taking your life in your own hands. It would throw you to the top of the car at both ends of the dip, and you can imagine how many unfavorable comments I heard from the people who traveled the road. Here was some of that criticism that I mentioned a while ago and which we all prefer not to get, but which is sometimes exactly what is needed to move us to action. In my case, I resolved that the first dip I had to design would certainly receive some attention as to grade line. I did not want another twenty-five mile-per-hour dip on a road designed for a speed of forty-five miles per hour.

I was working in Hood and Somervell Counties and due to the rough terrain, had several opportunities to gain additional experience in designing dips. An improved method of design was set up through the experience mentioned, and I believe that it is worth your consideration. The method of design that I want to present to you now is not claimed to be the best, and I know that some of you probably have a method equally as good, or even better; but I do think that at least a part of it will be beneficial to some of you.

There are several items of field data that are needed for this method of design, and they have been set up in five separate groups. They are as follows:

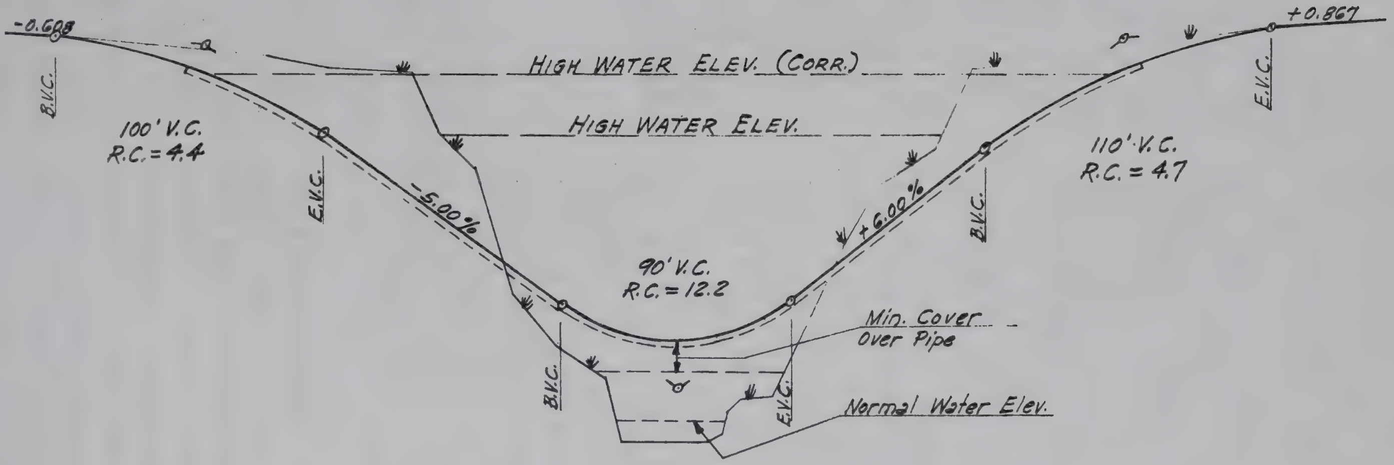
1. Stream Section and Roadway Cross Sections
2. Water Elevation at Normal Stage
3. Stream Meander, Profile and Topography
4. Highway Elevation
5. Drainage Area

Now we will go through the design procedure step by step, in order to give you a better understanding of the method's true value. (Graph Number 1) From the elevation of water in the stream at normal stage and the centerline profile as a section, you first determine the amount of opening necessary to handle normal drainage. This opening may be provided with one or more pipes and may be increased to handle a fairly large rain without overflow of the dip, if sufficient waterway opening is provided. From the stream profile, or cross sections, the flow-line elevations of the proposed pipe are determined, and then by providing minimum cover over the pipe, an approximate grade at the low point is found.

I want to take just a minute here to say a word about the low point in the grade line. On low water structures it is very important to hold the grade elevation to a minimum above the stream bed. This is particularly true of dips on account of the water pressure against the structure, and it will naturally become greater with each additional foot of height. This is also true for any type of low water structure because of the possibility of drift collection, the removal of which may sometimes

MAX. RATE OF CHANGE VALUES

	C.D.	C.U.
FARM HIGHWAYS (45 M.P.H.)	10	15
STATE HIGHWAYS (60 M.P.H.)	8	12



RATE OF CHANGE EQUATION

$$r = \frac{G_1 - G_2}{L}$$

EXAMPLE ~

$$r = \frac{-5.0 - (+6.0)}{0.9} = 12.2\ \%$$

GRAPH No. 1

LENGTH OF VERT. CURVE EQUATION

$$L = \frac{G_1 - G_2}{r}$$

EXAMPLE ~

$$L = \frac{-5.0 - (+6.0)}{10} = 1.1\ \text{Sta. or } 110'\ \text{V.C.}$$

become a very costly maintenance operation. There appears to have been some disagreement in the past on the question of how high grade should be set above stream bed on low water bridges. You will occasionally see one that is too low for a high-water bridge and too high for a low-water bridge, which usually means that it is just right for the collection of drift. The utmost care should be taken in selecting the finished grade elevation for any type of low-water structure. And now to pick up where we left off with the design steps -- with the approximate grade at the low point and the roadway approach grades on each bank of the stream, we are now ready to work out the grade across the proposed dip. From what I have already said, I'm sure you know that this is one of the most important features of the dip because it is desirable to have an installation that will take traffic at the design speed of the highway, if possible. And too, we all know that John Q. Public is going to base his opinion of the structure almost entirely on the way it rides.

On the first dips not much attention was given to the grade line. We would build one and then see how it would ride. If it was rough, we would try for improvement on the next job. In other words, it was very much a method of cut and try, and we never quite knew just what we had until the dip was completed and we could ride over it for a test.

The lengths of vertical curves we use have much to do with the final result. This is dependent on three things; they are (1) the total change of grade between the two tangents, (2) the safe rate of change of grade per station, and (3) the necessary sight distance. The first two points are most important, while point number three is desirable, but must on occasion be sacrificed to some extent, and in rare cases overlooked almost entirely to fit the dip to the stream crossing. Ordinarily the curves should be made as long as conditions will permit for best results.

We have been using an equation for some time now to determine the "Rate of Change" on our dips and after continued use, together with some field tests, have found that the desired length of vertical curve to give the best riding dip can be predetermined through its use. It is, by definition, as follows:

$$r = \frac{G_1 - G_2}{L}$$

Where r is the rate of change in per cent per station,

G_1 and G_2 are the two given grades in per cent,

And L is the length of vertical curve in stations.

The grades G_1 and G_2 are considered positive when ascending and negative when descending and are used with their proper algebraic signs in this equation. They amount to the same thing that we commonly call the "Algebraic Difference" in the solution of vertical curves.

For example, if we have a descending grade of five per cent meeting an ascending grade of six per cent with a vertical curve length of 90 feet, the solution of the equation is as follows:

$$r = \frac{-5.0 - (+6.0)}{0.9} = 12.2\%$$

At first this equation was used to determine the "Rate of Change" on the dips already built, and then by driving over them in an automobile at varying rates of speed until the maximum safe speed was determined, a maximum "Rate of Change" was determined for Farm to Market Highways or a design speed of 45 miles per hour, and for State Highways or a design speed of 60 miles per hour. The maximum "Rate of Change" for Farm to Market Highways was set at 15. For roads designed for 60 miles per hour, the maximum "Rate of Change" was set at 12. Further experience revealed the fact that, due to the pull of gravity, weight of the vehicle, etc., we could not use as high a "Rate of Change" value on curves breaking downward as we could on those breaking upward. For that reason our original values were revised as follows:

Maximum Rate of Change Values

	Curves Downward	Curves Upward
Farm Highways (45 M. P. H.)	10	15
State Highways (60 M. P. H.)	8	12

These are maximums and should not be exceeded, but the use of lower rates in both cases will naturally be better, and should always be used if the cost of the dip is not increased too much by so doing, or if the money is available in the project.

With these maximum "Rate of Change" values known we can change the equation to solve for the length of curve, as follows:

$$L = \frac{G_1 - G_2}{r}$$

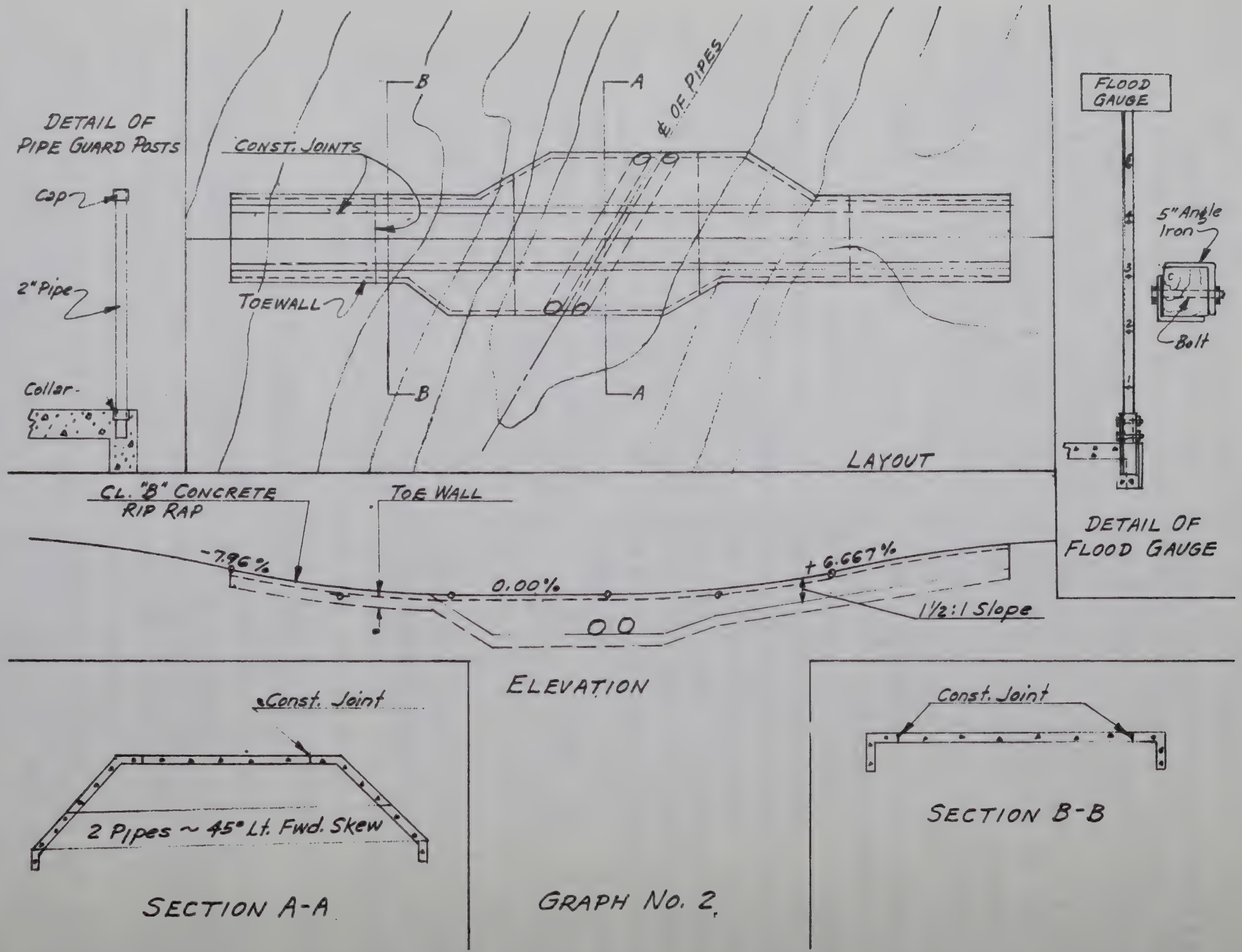
For example, if we have a descending grade of five per cent meeting an ascending grade of six per cent with a rate of change value of 10 desired, the solution of the equation is as follows:

$$L = \frac{-5.0 - (+6.0)}{10}$$

= 1.1 Stations or 110 feet vertical curve

Through the proper use of this equation, I feel safe in saying that you can eliminate the rough riding dips completely.

The next step in design is to determine the length of the dip to be riprapped, or protected from flood waters. This is done by first calculating the area below high water in the natural stream. With this information a corrected high water elevation can be determined by taking into account the obstruction of the stream by the construction of the dip across it. If funds are available, the ends of the dip should be located at approximately the corrected high-water elevation. This gives maximum protection at flood stage. If, however, due to limited funds,


DETAIL OF
PIPE GUARD POSTS
Cap
2" Pipe
Collar
CONST. JOINTS
TOEWALL
B
B
A
A
℄ OF PIPES
LAYOUT
FLOOD GAUGE
5" Angle Iron
Bolt
DETAIL OF
FLOOD GAUGE
CL. "B" CONCRETE
RIP RAP
TOE WALL
-7.96%
0.00%
+6.667%
1½:1 Slope
ELEVATION
Const. Joint
2 Pipes ~ 45° Lt. Fwd. Skew
SECTION A-A
Const. Joint
SECTION B-B

GRAPH No. 2.

it is necessary to cut down the length of the dip, it can be done in most cases without creating too much of a maintenance problem if care is taken in selecting the proper place to begin and end the concrete. The central dip area carries the main volume of water with the damaging velocities, and usually the drainage near the outer edges of the flood water will not cause too much damage to a base and surface if it does not stay up for prolonged periods of time.

We have been using five inch or six inch thicknesses of Class "B" Concrete Riprap reinforced with either wire mesh or bar steel for these dips and paving them completely -- across the roadway and down the slopes and with good deep toe walls all around. (Refer to Graph Number 2) This is placed on the compacted embankment previously placed over the pipe to handle normal drainage. The concrete pours have been broken down to average size by the use of construction joints placed both longitudinally and transversely. These joints are dowelled and painted with a heavy grade of oil asphalt prior to placement of the adjacent section.

A standard flood gauge, two dip signs, and enough two-inch pipe posts to effectively define the crown lines across the main channel have been installed on our dips as a part of the contract. The flood gauge is mounted in a bracket made by embedding two 5" x 5" x 18" angles in the concrete approximately nine inches. The post is anchored in the bracket with bolts, and if broken by drift or otherwise, it can be replaced without tearing into the dip concrete.

This, in effect, completes the design of the dip, but one more step should be taken to justify its use. The drainage area should be used to determine the size of conventional structure required in order that a comparative estimate of cost between the two can be made. For the larger streams the dip will always be considerably cheaper, but in the case of small streams where it is possible to handle the drainage with a large single or multiple box culvert, this is not always true. Therefore, it is good engineering to check on this feature before final selection is made.

In Somervell County on the Farm Road from Glen Rose to Lanham Mills, F. M. 205 I believe, we constructed a dip of this type across the Paluxy River about two years ago at a cost of slightly less than $10, 000. A bridge of sufficient length to span the river at this location would have cost in the neighborhood of $300, 000; so you can readily see that there is a place in our work where dips really pay off for us. The cost of a bridge at this crossing was prohibitive on the low type road, whereas the dip was economical and is serving traffic nicely and should continue to do so for a long time.

In closing, I would like to remind you again of the importance of a smooth and safe riding grade line across our dips. Give this feature of the work a little more study in the design stage, and I believe that in nearly all cases we can provide dips that can be traveled over at the design speed of the highway on which it is to be placed.

District 14 Experiments in

Reducing Flying Seal Coat Aggregate

H. C. CARTER
District Construction Engineer
TEXAS HIGHWAY DEPARTMENT

H. C. CARTER
Austin, Texas

Most big business concerns operate under the theory "the customer is always right." The Texas Highway Department is a big business concern and our customers, the traveling public, are demanding surfaces free from flying aggregate. We in District 14 think they are right. It is known that the highway system of Texas could never have reached its present magnitude without the use of many miles of low cost surface treatment. It is thought that we cannot afford to have the public look upon this phase of our work with disfavor. The fact that a lot of factors are now causing many difficulties with our light asphalt surfaces presents a real challenge to us all. It is realized that each of the 25 districts have been, and are, working on this problem, and this paper is presented as a status report on what one of the districts is doing. It is presented as the work and thoughts of District 14 and not necessarily as that of an individual.

It is generally agreed that a light asphalt surfacing, whether it be a double, a single, or a seal coat, should protect the base or other surfacing from water and/or air, should be nonskid, should be smooth, should be economical to construct and maintain, should have a reasonably long life, etc. These are engineers' requirements. The traveling public might prefer that the pavement be pleasing to the eye, quiet, highly visible at night, and certainly free from hazards such as flying aggregate. It follows than that all these factors must be considered if we are to satisfy our customers. It is believed more adverse criticism has resulted from slick pavement and flying stone than from all other sources combined.

What is the cause of slick pavement? In a majority of cases it is the result of bleeding. What is the cause of loose aggregate on the surfacing? In a majority of cases it is the result of treating bleeding. Treating a bleeding surface is recognized by the engineer as an expensive necessity, but to the traveling public it is a nuisance and a hazard. District 14 is now of the opinion that the best cure for bleeding surfaces is a preventive cure; that is, build the surfaces so they will not bleed. It is believed they can be constructed without an excess of aggregate, and a good textured surface can be maintained without bleeding. When this is accomplished, we will have achieved a major step in this public relations problem.

Seal Coats: Even though it may be repetition to many it is considered advisable to review some of our experiments, the first of which was on U.S. 81 in Travis and Hays Counties. This is a three lane facility and is carrying between 4,000 and 5,000 vehicles per day. The two outside lanes were sealed in September, 1948. In the months following this work it appeared that the number of accidents was reduced. To check this, information was obtained from the Department of Public Safety as to the number of accidents during the year immediately prior to placing this seal coat (October 1, 1947 to September 30, 1948). Also the same information was obtained for the year following the placing of the seal coat (October 1, 1948 through September 30, 1949). The results are shown in Table Number 1.

The number of fatal accidents, the number killed, and the total number of accidents were reduced. It will be noted that there was a 17 per cent increase in accidents when the pavement was dry (our guess is that the new uniform texture caused an increase in speed), but a rather large decrease in accidents when the pavement was wet or icy. These figures show a marked decrease in total accidents although the traffic count near the north city limits of San Marcos shows an increase of 8.1 per cent in volume between 1947 and 1949, and 8 per cent increase in volume near Williamson Creek for the same period.

The only change in the condition

Table Number 1

	Fatal Accidents	Number Killed	Total Accidents	Road Condition		
				Dry	Wet	Icy
Before Sealing Oct., 1947 to Sept. 30, 1948	6	10	66	35	26	5
After Sealing Oct. 1, 1948 to Sept. 30, 1949	3	4	49	41	6	2
Decrease	50%	60%	26%	--	77%	60%
Increase	--	--	--	17%	--	--

of this road which might have attributed to this decrease in accidents was a rather inexpensive seal coat applied on the two outside lanes only. This seal consisted of 0.12 gallon per square yard of high viscosity emulsified asphalt on 8.2 miles in Travis County and 0.15 gallon per square yard of the same asphalt on 15.2 miles in Hays County. Both jobs were covered with 5/8 inch washed, crushed limestone gravel aggregate.

Materials: Let's review the materials and their changes which have been used during this period.

The asphalt used in the original work was a high viscosity emulsified asphalt, the specifications for which are shown in Table Number 2.

Table Number 2

"HIGH VISCOSITY EMULSIFIED ASPHALT"

The material shall be homogeneous. It shall show no separation of asphalt after thorough mixing, shall meet continuous, the viscosity requirements at any time within thirty (30) days after delivery, and shall meet the following requirements:

	Min.	Max.
Viscosity at 122° F.	100	600
Residue From Distillation %	65	
Demulsibility 50 cc, 0.02 N. $CaCl_2$		30
Settlement (10 Days) %		3
Sieve Test, %		0.05
Penetration Residue at 77° F.	100	200
Solubility in CS_2	97	
Ash %		2
Ductility Residue at 77° F.	40	

In the spring of 1949 the asphalt was changed to "rapid setting high viscosity emulsified asphalt," the specifications for which are shown in Table Number 3.

The rate of application has been varied from 0.12 gallon per square yard on rich and/or slick pavements up to .22 gallon per square yard on dry, raveling or open textured pavements. The shooting temperature for both types of emulsion has been held in the 150° F. -- 160° F. range.

This District has felt for a long time, due to increased traffic and heavier loads, that the aggregate specified in "Red Book" Item 303A (Seal Coat), and shown in Table Number 4, was too small. The aggregate soon becomes pushed into or wetted with asphalt, and the result is always bleeding. The first step away from this small aggregate was a special 1/2 inch grading as shown in

Table Number 3

"RAPID SETTING HIGH VISCOSITY EMULSIFIED ASPHALT"

The material shall be homogeneous. It shall show no separation of asphalt after thorough mixing, shall meet continuous, the viscosity requirements at any time within thirty (30) days after delivery, and shall meet the following requirements:

	Min.	Max.
Viscosity at 122° F.	100	300
Residue From Distillation %	65	
Demulsibility 35 cc of N/50 $CACL_2$	30	
Settlement (10 Days) %		3
Sieve Test, %		0. 1
Penetration Residue at 77° F.	100	200
Solubility in CS_2.	97	
Ductility Residue at 77° F.	40	

Table Number 5.

Table Number 4

Red Book Item 303A "Seal Coat"

Retained on 1/2" screen	0%
Retained on 3/8" screen	0-10%
Retained on 10 mesh sieve	95-100%

However, after using this aggregate it was felt that it, too, was too small and the seal coats described herein have been placed using the number one aggregate of "Red Book" Item 305, the grading of which is shown in Table Number 6. This is very nearly the same aggregate as shown in the new Specification S-351, Grade 5. This District has not favored the use of larger aggregate because of the rumbling or roar created by the tires. All of the aggregates have consisted of broken limestone, crushed gravel, or natural limestone rock asphalt. The specifications for contract work have contained the requirement that 85 per cent of the fragments contain at least one crushed face. When materials were purchased directly by the state, the requirement that 65 per cent of the material by weight contain at least one crushed face has been used. This latter requirement was introduced because it resulted in a cheaper yet satisfactory material since some of the producers in

Table Number 5

Special Provision to Item 303A "Seal Coat"

Retained on 1/2" screen	0%
Retained on 3/8" screen	5-20%
Retained on 10 mesh sieve	95-100%
Retained on 20 mesh sieve	98-100%

this area have to crush some of the larger sizes and recombine in order to meet the 85 per cent crushed particles requirement. The rate of application has varied from 1:130 to 1:170, probably the average would be 1:150. Our experience has indicated that without close supervision most of our personnel, both resident engineers and maintenance foremen, invariably will apply too much cover material. The ideal is to apply only sufficient to cover the surface and to leave any surplus in the stock pile.

Table Number 6

Red Book Item 305 "Number 1 Aggregate"

Retained on 5/8" screen	0%
Retained on 1/2" screen	0-10%
Retained on 1/4" screen	70-100%
Retained on 10 mesh sieve	95-100%

Rolling: The surfaces have been rolled one time with a five ton flat wheel roller and this has usually been all the rolling necessary. When the surface being sealed was rough to the extent that areas of the pavement would not be in contact with a flat wheel roller, pneumatic rolling has been used; but it is necessary to exercise care in the turning of the roller to avoid scarring or blacking up the new surface.

Brooming: Due to the tenderness of the seal coat between the time it was covered and the time it was opened to traffic, it was not broomed since a drag broom would loosen and turn some of the aggregate over. By the time the asphalt has cured sufficiently to permit brooming there has been no loose aggregate either partly coated or clean on the surface.

Cost: It must be realized that the cost of this type surfacing is contingent upon many factors including the cost of the materials, the type and amount of aggregate, and the distance equipment is moved to reach the project. Table Number 7 shows some typical cost figures for seal coats.

Protection of Seal Coats: It is

the opinion of this District that the most important single phase of this type seal coat is the proper protection of the work for the first few hours after placing the seal coat. Surfaces during this initial time can be completely ruined, that is, the aggregate whipped off and the surface left black or streaked by fast moving traffic. All this type work has been shot in 1/2 widths with the exception of the lighter traffic Farm to Market roads. Beginning with the asphalt season in 1949 all traffic was stopped by flagmen using the "Stop, Ask Watchmen for Road Information" signs. The flagman controlled traffic with his right hand while holding a red flag in the left hand to attract attention. The traffic was told that we were placing a nonskid treatment on the highway, to drive on the left-hand side of the road, and to please drive slowly until he had passed the next flagman. The flagman on the opposite end stopped all traffic explaining the work and asking the traffic to drive on the right-hand side and to move on the shoulder when he would meet traffic and to drive slowly until he had passed the flagman ahead. The flagmen for this work were selected with great care and the men used were college engineering students. The men were well-dressed, neat, had a good command of the English language, and had the ability to look directly into the face of the motorist while giving him instructions. Beginning with the 1950 asphalt season in addition to the above procedure, the motorist has been given the little cards explaining the seal coat program. It was found that probably 99 per cent of all traffic responded to the instructions, but in those instances where the car did not stop, the flagman took his license number, a list of which was furnished the

Table Number 7

Cost of Emulsified Asphalt Seal Coats

Year Placed	Hwy.	County	Rate Emulsion	Rate Cover *	Cost Per Sq. Yd.	Width Feet	Cost Per Mile**
1948	US 81	Travis	.133	1:149	0.044	20	$ 516
1948	US 81	Hays	.148	1:150	0.048	Variable	---
1949	US 281	Burnet	.175	1:126	0.059	20	692
1949	St. 29	Burnet	.162	1:132	0.063	24	887
1949	US 290	Travis	.180	1:149	0.065	Variable	---
1949	US 290	Travis	.182	1:124	0.064	20	751
1949	US 81	Wm'son.	.184	1:130	0.071	24***	1000
1949	US 81	Wm'son.	.171	1:150	0.086	24***	1211
1950	St. 16	Gillespie	.192	1:152	0.068	26	1037
1950	St. 29	Burnet	.182	1:144	0.057	24***	803

* Includes waste at stockpiles, etc.

** Does not include widening or side road turnouts.

*** Original surfacing was twenty feet. Cost as shown includes double on widened two feet on each side.

Insurance Division, who in turn wrote the motorist a form letter as described in Insurance Circular 2-47, dated July 18, 1947. On a few short projects and in isolated areas the use of regular maintenance employees for this flagging work has been necessary. However, we are frank to state that this flagging was less effective than when we were using the higher type men.

The normal procedure would be to begin shooting in the morning, say on the right side of the road using the center stripe for guide line and continue shooting until about 11 o'clock, then stop the work until 1 o'clock. During this entire period the work shot would be protected against traffic by the flagmen described above and by additional short barricades and additional flagmen if necessary throughout the section. At 1 o'clock this section would be open to traffic and in the afternoon the opposite side would be shot similarly to that described above. The shooting would be stopped early enough in the afternoon to allow a minimum of two hours curing time before the road was completely open to traffic before dark. If the shoulders being used by traffic were dry and dusty, they would be sprinkled to eliminate the dust hazard and to keep the dust off the fresh asphalt.

Double Applications: Another of our experiments has been the use of rapid setting high viscosity emulsified asphalt in two course surface treatments. Various combinations were tried and are shown in Table Number 8.

Combination Number 1 was used on a section about two miles long. The MC-3 was applied in the winter in sections, as a new base was completed and covered, 1:140, with the same 5/8 inch stone mentioned throughout this article. The following summer the second course was applied and covered, 1:160, with the same aggregate.

Combination Number 2 was used on a section about one mile long. Both courses were shot within a few days and were covered with 5/8 inch aggregate. More material was used on the first course.

Combinations Number 3 and 4 were used on sections one mile in length. Both courses were applied the same day and both covered with 5/8 inch aggregate.

Combination Number 5 has been used on about 23 miles. On part, both courses were applied on the same day; and on part, the first course was kept out ahead to protect finished base. Five-eighths inch aggregate was used to cover both courses. The average rate of cover of the first course was

Table Number 8

Number	1st Course Asphalt	2nd Course Asphalt
1	.25 gal. MC-2	.20 gal. RSHV Emulsion
2	.25 gal. OA-135	.20 gal. RSHV Emulsion
3	.25 gal. RSHV Emulsion	.25 gal. RSHV Emulsion
4	.20 gal. RSHV Emulsion	.25 gal. RSHV Emulsion
5	.20 gal. RSHV Emulsion	.20 gal. RSHV Emulsion

about 1:140 and the second course was about 1:160.

To date the results have been highly satisfactory for each of the combinations tried.

Precoated Cover Materials, Laboratory: This District recently conducted some laboratory experimental work with precoated cover materials. Nine different types of aggregate were accumulated and samples were prepared of various combinations including crushed limestone, washed and unwashed; limestone gravel, crushed and uncrushed; rock asphalt; and siliceous gravel. A portion of each of the samples was separated without precoating, a portion treated with a 10 per cent solution of EA1OS emulsified asphalt, and a portion was treated with a 15 per cent solution of EA1OS emulsified asphalt. Also a sample of rock asphalt precoated material and a sample of crushed limestone precoated material were obtained from commercial producers. Aggregate retention tests were run by the Materials and Tests Division, the method of which was described by Marshall Brown at the 23rd Annual Short Course and was transmitted by Administrative Circular 19-49, dated March 22, 1949. In all, 27 tests were run using rapid setting high viscosity asphalt and 27 tests of the same combinations of aggregates were run using OA-230 asphalt. The results of all of this laboratory work have been studied but no conclusive evidence is apparent that would indicate the precoated material to be better than the uncoated material. This precoating in the laboratory amounted to preparing a 10 or 15 per cent solution of EA1OS emulsion (slow setting type). The aggregates were then dipped into the solution and allowed to dry in the open air. The amount of asphalt precoating, after drying, was determined to be between 0.16 per cent and 0.35 per cent by extraction.

Precoated Cover Materials, Test Sections: In addition to the laboratory work mentioned above, this District recently, in cooperation with the Maintenance Division, conducted some experimental work using the construction methods described in this article except that a number of precoated stones were used along with the same materials uncoated. All the materials used conformed in grading to that shown in Table Number 6 (Number 1 stone of Item 305) except the rock asphalt precoated material was a little heavy on the amount retained on the 1/2 inch screen. The materials used and the lengths of the sections are shown in Table Number 9.

Section Number 1 was a crushed limestone material which had been washed and contained no minus ten mesh sizes. Section Number 2 was the same aggregate which was precoated by our own forces by mixing in a bituminous mixer using a 15 per cent solution of EA1OS emulsified asphalt. Section Number 3 was a washed, crushed limestone gravel. Section Number 4 was the same as Section Number 3 except the limestone gravel was precoated by our own forces with a 15 per cent EA1OS emulsion solution. Section

Table Number 9

Precoated Cover Materials

Section Number	Sta. to Sta.	Description	Rate Emulsion	Rate Cover	Cost per C.Y Applied *
1	28+41 43+71	Washed broken limestone	0.15	1:170	$ 3.34
2	43+71 59+01	Washed broken limestone precoated - 15% EA1OS Solution	0.15	1:170	4.34
3	59+01 74+31	Washed crushed limestone gravel	0.15	1:170	4.21
4	74+31 89+61	Washed crushed limestone gravel precoated - 15% EA1OS Solution	0.15	1:170	5.21
5	89+61 104+91	Rock asphalt cover material	0.15	1:170	5.62
6	104+91 120+21	Rock asphalt precoated material	0.15	Lt 1:112 Rt 1:136	6.12
7	120+21 135+51	Unwashed broken limestone	0.15	1:170	5.28
8	135+51 150+81	Precoated limestone .7% OA-230	0.15	1:170	6.12

* These costs vary because materials were from several different sources, etc.

Number 5 was covered with rock asphalt cover material. Section Number 6 was covered with rock asphalt precoated material. Section Number 7 was covered with crushed limestone containing 5 per cent minus ten mesh material. Section Number 8 was crushed limestone precoated with .7 per cent OA-230 asphalt. The asphalt used in this test work was the same for all sections and consisted of 0.15 gallon per square yard of rapid setting high viscosity emulsified asphalt. The rate of cover was held at 1:170 except that additional material was required on the rock asphalt precoated material. (This was probably due to the coarser grading of the material).

Table Number 9 shows the cost of the precoated material as applied in the test sections. It will be noted that the materials treated by state forces cost $1 per cubic yard for the precoating. This cost could undoubtedly be lowered if a large quantity were treated. In the case of the rock asphalt cover materials, a net difference of 50 cents per cubic yard in cost is shown. In the case of precoated limestone a net difference of 84 cents per cubic yard is shown. Although the costs, as shown in Table Number 9, are not considered reliable since only a small quantity was involved and since the cost of moving a dragline to unload the materials was included, it does show that a long haul on precoated aggregate would be rather expensive as compared with available local aggregates. Other than the difference in price of cover materials the cost should not vary appreciably from the normal seal coats.

It is not believed that any definite conclusions can be drawn from this precoated test since each material precoated and the same material uncoated have all resulted in excellent seal coats with good texture.

Precoated Materials for Bleeding: A small amount of work was done using uncoated and precoated aggregates to treat a bleeding surface on a project shot early last spring on which OA-135 asphalt was used. The surface in question was bleeding in each of the two traveled ways and therefore the spreader box was blocked out so that the cover would be applied only on the bleeding area. The material was rolled immediately after placing and some of it stuck, but apparently the precoated material did not stick any better than the uncoated materials, and for several days after this treatment both types of aggregate continued to whip off until at the end of 30 days it was all gone. It is not believed the cost of precoated materials for this type treatment can be justified by the results.

Difficulties: What has been said should not be construed to mean that all of these surfaces have been constructed without difficulties. One of the early jobs gave trouble because the emulsified asphalt started breaking in the car. The further we shot the more difficulty we had, and by the time the car was empty the surface was badly streaked. The specifications have been changed to reduce the viscosity maximum from 600 to 300 in an attempt to avoid this difficulty. On another occasion the usual light application of emulsified asphalt and 5/8 inch cover material was applied but a large per cent of the cover material whipped off. In this case, it was not the asphalt because a quantity was carried forward to another job and the results were entirely satisfactory. It is believed this difficulty was caused by three factors. First, not enough asphalt was used since the old surface was dry and raveling. Second, too much cover material was used which resulted in the fines blotting out the coarser sizes. Third, flagmen were used on either end of the work but they were too far apart and as a result the new surface was used by traffic and therefore, not properly cured. This work was performed by state forces but this was the last project shot without close engineering inspection. We have attempted to develop a double asphalt treatment which might be used in the winter months, and because this work was felt to be experimental in nature, it has been confined to light traffic, Farm to Market roads. In one instance the first shot was applied and cured, and that afternoon it appeared to be satisfactory; but the temperature dropped to about 30° F. that night. By the next morning it had been badly damaged by the small amount of farm to market traffic which had used it during the night. It is believed an explanation of this difficulty might be traced to the method of manufacture of the emulsified asphalt. It seems that one producer, for convenience or otherwise, added a small portion of oil, perhaps kerosene, to the crude in the manufacture of this type emulsified asphalt and two or more producers had not followed this method. For summer shooting the material which contained the oil probably required a little longer initial curing time but when it was used in the wintertime, this oil fraction seems to keep the mat alive and it was not damaged by freezing weather. On the other hand, the emulsion that was manufactured without this oily portion seems to go through a more rapid curing stage, which probably was desirable in the summertime but was found to be quite detrimental for cold weather shooting. It is believed this problem has now been solved since all of the manufacturers are, so far as we know, adding the oily portion during the winter months even though such procedure is not required in the specifications.

Suggestions: As a result of our experiences with the use of rapid setting high viscosity emulsified asphalt, we have a few suggestions which are shown below:

Do:

1. Watch the high viscosity emulsified asphalt as it is being unloaded for signs of breaking. This can be detected by lack of flow through the pump or heater or by stopping up of the nozzles on the distributor spray bar. This has not been a serious problem in this District but it has happened.

2. Give the new seal coat ample and adequate protection for a few hours after it is shot. Delays such as two hours in the middle of the day may seem objectionable but they are much cheaper than the cost of fighting bleeding for the rest of the summer, not to mention the hazard to the traveling public of flying stone.

3. Provide adequate engineering inspection of the work in its entirety. In District 14 work performed by state forces is just as rigidly inspected as work performed by contractors.

Do Not:

1. Do not attempt to add water to the rapid setting high viscosity emulsified asphalt because in most cases the water will break the asphalt and the residue cannot be pumped.

2. Do not shoot emulsified asphalt in doubtful weather if the surface must be used by traffic, because a rain on the new surface will cause loss of aggregate, tracking, etc.

3. Do not get the idea that these very light inexpensive treatments as described herein will make a complete high type pavement or that they are a cure-all.

4. Do not attempt the use of this type seal coat on a large scale basis until you have tried it and become familiar with it on a small scale.

5. Do not allow the rapid setting high viscosity emulsified asphalt as shown in Table Number 3 to freeze. This District is purchasing for winter storage a high viscosity emulsified asphalt, the specifications for which are shown in Table Number 10.

Table Number 10

"HIGH VISCOSITY EMULSIFIED ASPHALT"

The material shall be homogeneous. It shall show no separation of asphalt after thorough mixing, shall meet continuous, the viscosity requirements at any time within thirty (30) days after delivery, and shall meet the following requirements:

	Min.	Max.
Viscosity at 122° F.	100	300
Residue From Distillation %	65	
Demulsibility 50 cc., 0.02 N $CaCl_2$		30
Settlement (10 Days) %		3
Sieve Test, %		0.05
Penetration Residue at 77° F.	100	200
Solubility in CS_2	97	
Ash %		2
Ductility Residue at 77° F.	40	
Freezing test 3 cycles	Passing	

Conclusion: It is our opinion that more projects have been spoiled by construction methods and misuse of materials than by the actual materials themselves. Most of you know more about "asphalt work" than your speaker and, if modesty wouldn't prevent, the boys back home would admit they know more about it than either of us. They probably are right and yet there are more failures in this type work than in any other single phase of our entire highway program.

It has been felt for some time there should be a rational method of designing these light asphalt surfaces. It is believed the first step would involve the aggregate to be used and that such factors as amount of dust, amount crushed, shape of particles, kind of stone, screen analysis, and probably other factors would be considered in arriving at how much aggregate could be stuck on the surface, one aggregate thick. Next, it is believed such factors as type and amount of traffic, climatic conditions, humidity, life of the asphalt, past performance of the materials for any chosen locality, and personal preference should be considered in choosing the grade of asphaltic product. From a consideration of above factors and others such as condition of surface being sealed, time of year applied, etc., the amount of asphalt might be determined. Last, construction methods such as shooting temperature, sequence of covering to shooting, brooming, rolling, protection from traffic, etc., should be considered.

District 14 does not have such a method to submit but has observed a few points which might be of interest. It is readily admitted that the following are the results of laboratory samples and probably would change considerably in actual practice, but in studying the results of the aggregate retention tests mentioned above a number of plottings have been made in an effort to isolate some of the factors. For example, without changing the asphalt the results of crushed vs. uncrushed aggregates have been plotted against the amount of aggregate retained and the same for washed vs. unwashed. After many such plottings the only real distinction found was the plotting of the amount passing the 1/4 inch screen of the aggregate against the per cent retention and the kind of asphalt used. These plottings are combined in Figure 1. In these laboratory tests the rate of cover was held constantly at 1:140. Above "per cent retention" in Figure 1 there is shown the calculated amount that was actually retained. The samples in which oil asphalt was used are plotted in circles and the samples where emulsified asphalt was used are plotted in squares. Without going into detail it will be noted that for an aggregate (Number 24) with 76 per cent passing the 1/4 inch screen 48 per cent (of 1:140) was retained with oil asphalt and 64 per cent (of 1:140) was retained with emulsified asphalt. Compare this with a sample (Number 2) with 10 per cent passing the 1/4 inch screen. Eighty-five per cent (of 1:140) was retained with oil asphalt and 97 per cent (of 1:140) was retained with emulsified asphalt. Narrow this down to the limits in aggregate, grade five, of our new standard specifications. The amount stuck could vary from 1:140 to 1:200. It would follow then that if the grading in a stockpile changed during a day's work the rate on the road would have to change, or some areas would be undercovered and some would be overcovered.

It is believed that, in a majority of cases, the surfaces are overcovered. This is occasioned by such thoughts as, "Don't let it bleed," "Don't make me come back later and add more material," "Let's use plenty aggregate." Whatever the reason, when a surface is overcovered the fines blot out the larger sizes, which in turn are whipped off the road. The result is that the screen analysis of the material stuck on the road has been changed mechanically. For example, a material may meet specification grade five with 39 per cent passing the 1/4 inch screen. Assume one-third of the larger sizes are blotted out and whipped off the road. Then the material actually stuck on the road would have 49 per cent passing the 1/4 inch screen and no longer meets the original specifications. Such a material was placed by hand on a framed glass of known area and the cover one aggregate thick was

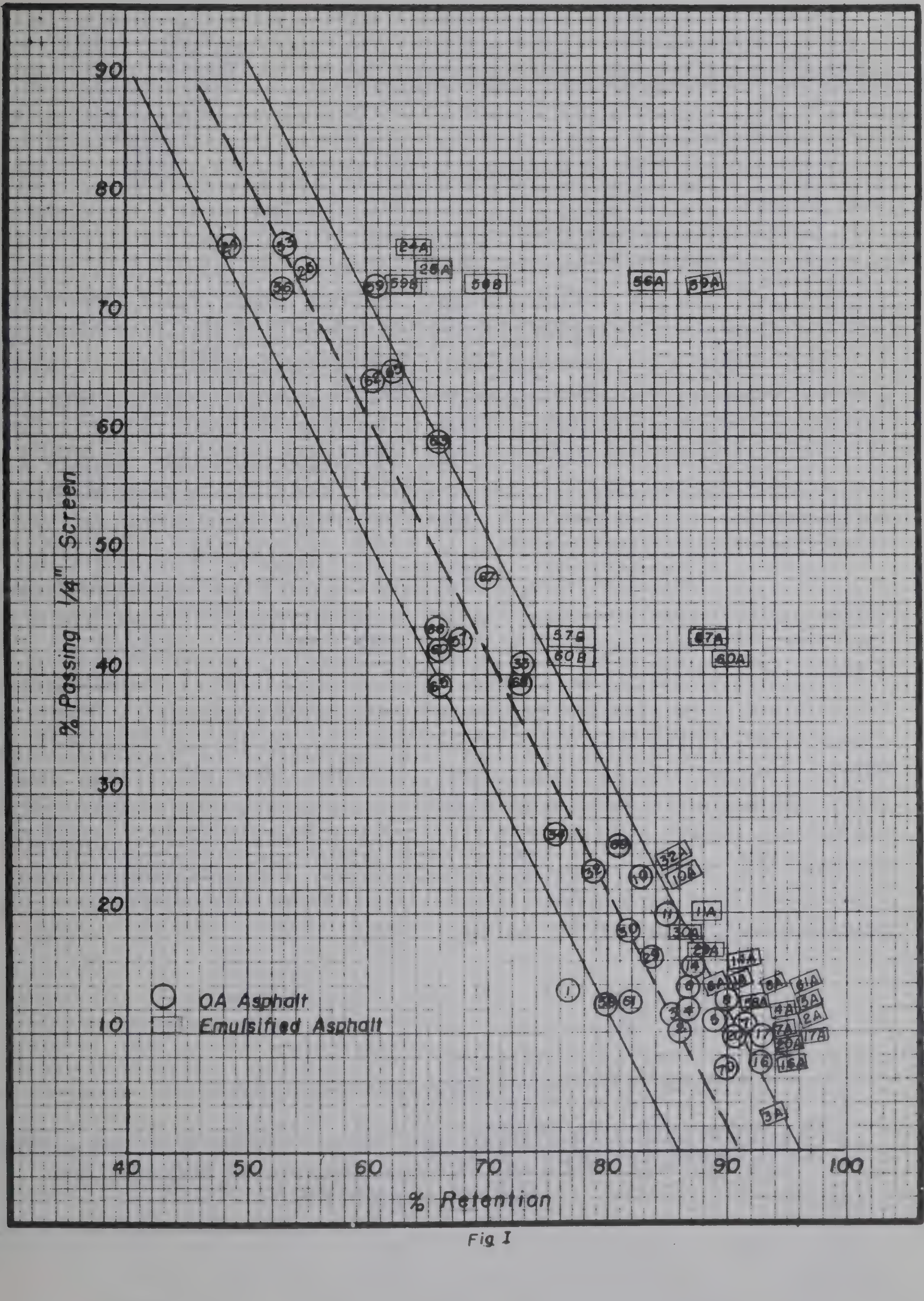

% Passing 1/4" Screen
90
80
70
60
50
40
30
20
10
% Retention
40
50
60
70
80
90
100
OA Asphalt
Emulsified Asphalt

Fig I

thirteen pounds per square yard. This cover on a .25 gallon shot of oil asphalt would result in a ratio of asphalt to aggregate of 16 per cent. Compare this with the .12 gallon of emulsified asphalt shot on US 81 and mentioned as our first experimental project. The ratio of asphalt to aggregate on that project was 4 per cent.

It is not known that these light shots will always provide the seal needed but rather than attempt the use of too much asphalt, it is recommended that two applications of asphalt with two applications of cover material be used. It is not now known if any of the factors mentioned herein need be eliminated or changed in the specifications; rather it is suggested, for the time being, they be recognized for their face value when used by our engineers.

There have been some difficulties in our District but for each disappointing project there have been a number of very good projects. Since the first work in 1948 there has been placed approximately 193 miles of seal coats and/or two course surface treatments using emulsified asphalt and available local 5/8 inch cover materials, and there is now planned another 146 miles. The results have been very satisfactory to date in that the surface is sealed, the texture is nonskid and presents good light-reflecting qualities, the hazards to traffic of loose aggregate are completely eliminated, there is no bleeding, and the treatment is cheap. It is true we also have some excellent seal coats in which 1/2 inch and 3/4 inch top size aggregate were used and we have had some good results when oil asphalt was used but the batting average has been much higher with emulsified asphalt and 5/8 inch top size aggregate.

The fact that this and other districts have found fairly successful combinations of asphalt and aggregate is not grounds for complacence. It is believed this supposedly simple, inexpensive treatment is, in reality, quite complex and additional study of materials, construction methods, and construction equipment is needed and certainly close engineering inspection is a necessity.

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Effectiveness of Proper Rolling of Asphalt Penetration Surfaces

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A concentrated study for the improvement of seal coat work in District 8 of the Texas Highway Department was started in the summer of 1939, and was brought about by the assignment of Mr. S. J. Treadaway as District Engineer. Prior to that time very little seal coat work had been done on the existing four or five hundred miles of asphalt roads. Seal coat work commanded very little importance, and naturally, was considered a "cut and dried procedure." Experienced asphalt engineering personnel was not considered essential to the successful completion of the work and usually consisted of only the necessary checkers to measure the amount of the contractor's daily production. Naturally, with this attitude, the asphalt surface after sealing gave the effect of "having happened," rather than having been well planned and supervised by competent engineering personnel.

Because of the wide range of climatic conditions; that of very severe winters on the one hand and very hot summers on the other extreme, plus what might be termed a semi-arid area, experience taught us that to properly maintain asphalt surfaces, and to insure against base failures and other deformities in the pavement, we should seal our asphalt surfaces on an average of four or five years. If this policy of maintenance were to be followed, it meant to us that from 200 to 300 miles of our asphalt surfaces would necessarily have to be sealed each year in order to keep abreast of the problem. That amount would increase as newly constructed roads added more miles of asphalt pavement to the highway system in the district.

It was evident that such factors as weather, type and size of aggregate, type and grade of asphalt, together with type and volume of traffic under usual design and construction procedures, gave us as many different patterns of completed surfaces as there are changes and combinations in all of the above factors.

There was no doubt then that much improvement could be made and must be made in the quality of seal coat work in the district. With this in mind, Mr. Treadaway has been continuously insistent that every possible means be used to improve this work. It was the consensus of opinion among the engineers working in the district that the desirable characteristics of a completed asphalt seal coat should consist of four chief characteristics:

1. It should provide a durable protection to the old pavement from surface water, sunlight, and air.
2. The completed surface must be safe to the traveling motorist during all types of weather, and it, therefore, must be non-skid.
3. All seal coat work placed under the same specifications and under the same construction procedures should have a uniform texture and color.
4. During the construction and maintenance period, the traveling motorist should be subjected to the minimum amount of inconvenience, and if possible, be free from the hazard of flying cover stone.

Any asphalt surface in need of the first two factors, namely that of protection to the surface and base and the elimination of slick pavements, would justify the expenditure for a seal coat.

It was not unusual to hear such comments by our engineers after failure to secure the desired results on penetration asphalt work: "This procedure gave us a good job on Highway Number 1. Why should it not give us a good job on Highway Number 2?" It was not uncommon to hear maintenance personnel describe a newly placed seal coat in this manner: "The new seal coat is bleeding." "Cover material is flying, breaking windshields and headlights." "The road is going to be slick." Buy some more cover material on emergency purchase." "Blade or broom the cover material from the shoulders of the road." "It looks like we will be working on this seal coat the rest of the summer." "Can't do anything to regular maintenance because we have to take care of a new seal coat." "We have spent more money in an effort to cure the new surface than the original cost." And a comment from a traveling motorist would be this: "Let's detour that road. I had rather drive a hundred miles than take my car through that new asphalt job." Sometimes, this story continues the following summer on the same project. Please bear in mind that these are our particular experiences and comments made in our area during the last eleven years.

The cost of two of the above items, namely broken glass and slick pavements, cannot be accurately estimated. A tabulation of all comprehensive items from glass breakage on automotive vehicles from all the insurance companies plus the expense by users of the highways for damage which was not insured, would give you the cost of flying stone on newly placed asphalt seal coat work. The subjection of the traveling public to slick pavements during wet weather should be prohibited. It is our opinion that a condition of this kind should be corrected and given precedence to anyother type of work pertaining to the construction and maintenance of our highway system. The cost of slick pavements to the traveling motorist can be measured only by property damage, personal injury, and death to the users of our highways.

It is possible that if steps are not taken to eliminate these objectionable features that the users of our highways will so vigorously object to these conditions that on some roads the use of seal coat would be prohibited.

It is our considered judgment that experienced engineering personnel should be assigned to the study of the problem of improving the design and construction procedures now being used on penetration asphalt work. The plans, specifications, and construction procedures should be so exacting that the best of mechanical equipment would be furnished by the contractor on work of this type, and further that skilled operators for this equipment should be available at all times.

As stated in the beginning, the design and construction procedures now in use on seal coat work in District 8 of the Texas Highway Department have evolved from many trials of combination of materials and uses of equipment. For that reason it is appropriate to discuss some of the factors that influence the design and construction of a satisfactory asphalt seal coat.

1. Selection and Grade of Asphalt Material to be Used: Manufacturers of asphaltic materials are usually able to satisfy the desire of the engineers working in the varied climatic conditions of the country. Engineers have learned through experience and by laboratory testing which type of asphaltic cement gives the best results in their particular area. Generally, the consensus of opinion is that lower penetration asphalts are suitable for hot, humid areas. Rapid curing cutbacks are adapted to the cooler climates. The rapid breaking, high viscosity emulsions can be favorably used over a broad range of climatic conditions. The choice of any asphalt material should be seriously considered by the designing engineers and its selection should be based on performance of this material in their particular area. They must consider type and volume of traffic, the condition of the old surface, and type and quality of cover material which will be on hand for use.

2. Quantity of Asphaltic Material Required: The quantity of asphaltic material required, that is, the rate of distribution, is certainly a factor which would influence the result of any type of asphalt work. Since the state of deterioration on the old surface governs the need of seal coat, each may require a different rate of application. Rough textured surfaces which are raveling will necessarily require heavier application because of some absorption of the materials by the old surface.

I am sure that each of you has observed that a change from a rough surface to a smooth, slick surface may occur many times within the limits of one project. Variation in the rate of application of asphalt should be made in accordance with these changes. Whether it be a problem of seal, color coat or slick pavement, the texture of the old surface would certainly govern the rate of application of asphalt. Perhaps the most important factor of all in making this determination is the maximum size of the cover material to be used and how this cover material is to be manipulated before it is embedded into the asphalt.

3. Aggregates: With the wide range in gradation and quality of aggregate now being used on penetration asphalt work, the word aggregate has come to mean most anything. It goes without saying that engineers have one preference for a particular type of aggregate which is available for use in their particular area, but the economics of the problem which is always a factor makes it necessary for them to use many types of aggregate. Allowance always must be made for the physical characteristics of the aggregate to be used. The experienced engineer will be thoroughly familiar with these various characteristics. Some of the common types used are: screened gravel, crushed gravel, and crushed rock of which there are many geological types of this classification; crushed limestone and lean limestone rock asphalt. In some localities precoated aggregates are available for city work where it is highly desirable to eliminate the hazard and nuisance of dust. It has been our experience that the selection of gradation and the maximum effective size of the cover aggregate has a greater bearing on the results desired than any other factor in the placing of an asphalt seal coat.

To intelligently select the size and gradation of the aggregate, the manipulation and procedure of placing the aggregate on the road must be carefully planned in advance. It is all important that the selection of maximum effective size gravel and gradation be in keeping with the rate of application and type of asphalt. It has been our observation both in maintenance and construction work that the maximum effective size of the aggregate should be such that the aggregate will extend through the asphalt surface after the curing period to such an extent that traffic will be just riding on the maximum size aggregate rather than in the asphalt. Our experience with many types of aggregate and varying screen analyses from fine to coarse has shown that material passing the ten mesh sieve should be excluded from the aggregate as nearly as possible.

4. Construction: You will agree that the construction methods used in placing penetration asphalt work can either make or break a satisfactory job. Here, again, let it be emphasized that experienced engineers and inspectors are worth their weight in gold to the final results of an asphalt seal coat. It is believed that a description of the various inspections and procedures now being carried on in District 8 of

the Texas Highway Department would best give you a picture of what we have in mind. Immediately after the arrival of the contractor's equipment on the project, competent asphalt inspectors check the equipment to see if it is in proper working order. Naturally, one of the most important pieces of equipment is the pressure type distributor. First, the distributor should be mounted on a truck which is large enough to satisfactorily carry the load and with power enough to start the load at the beginning of the shot and to gain immediately and hold a predetermined rate of speed. Second, the truck should have such braking capacity as to permit it to stop on a thirty inch lateral paper at the end of the shot. The distributor must be equipped with a tachometer which indicates the revolutions per minute of the distributor motor. The truck must be equipped with a tachometer which indicates the feet per minute traveled by the truck. Naturally, a coordination of these two gives you uniform application of asphalt.

Prior to placing the asphalt, an inspection should be made inside the distributor in order to determine if any coke deposits have formed inside the tank due to previous use as a heating unit. Most modern distributors are equipped with screens which gather any foreign materials and eliminates the possibility of such particles getting into the spray bar and nozzle. Cleanliness inside a distributor usually means good work with a distributor. All connections relative to the plumbing of the distributor should be checked for leaks. If the inspecting engineer is not familiar with the manufacturer's recommendation as to the operation of the machine, he should ask the contractor to provide him with their recommendations.

Next, all the nozzles on the spraybar should be checked for uniformity both as to the size of the orifice and as to the angle setting with relation to the spraybar. Usually, the recommendations of the manufacturer can be followed very closely in regard to the height of spraybar or nozzle tips above the pavement. This is very important and may be the cause for streaking or irregular application. It has been our experience that overland transportation of an asphalt distributor from one job to another will in many cases get it out of adjustment. Periodically, during the construction of the job the same steps should be taken to see that everything is in order.

Experienced, conscientious operators are, of course, necessary for the proper operation of an asphalt distributor.

Where a usual volume of production is expected by the contractor, he will necessarily have sufficient asphalt storage and suitable asphalt heating equipment. There should be attached to the heating unit, as a precautionary measure, and as prescribed by the manufacturer, a recording thermometer which would give to the engineer the range of temperature to which the asphalt has been heated.

An aggregate spreader in satisfactory working order should be provided by the contractor together with very experienced operators. It has been our experience that in the successful operation of the cover crew one man should back the truck which is unloading into the spreader box, as it is almost impossible for a number of truck drivers on any particular project to develop the technique necessary to give an accurate and uniform coverage with the spreader box.

Satisfactory loading equipment to handle the cover material should be provided by the contractor. Usually, this piece of equipment does not present much of a problem to the engineering personnel, as the contractor must provide adequate loading facilities for the cover material. The necessary drag brooms, rotary brooms, pony blades, and incidental equipment should be readily available at all times.

There are many more detailed checks that should be made that are essential before the asphalt work is started such as:

1. Clean pavement.
2. Line guide.
3. Accurate and uniform loads of aggregate.
4. Stone spread lengths.
5. Predetermined length of shots.
6. Accurate calibration of distributor tank.
7. Provision for traffic.

After all checks have been made of the contractor's equipment and personnel, the engineer's inspectors are then given their various assignments. In the beginning of this paper, it was brought out that there were four main objectives which we decided to accomplish by placing a seal coat. Namely, to seal the pavement; to produce a non-skid surface; to obtain a uniform texture and color; and to eliminate the hazard of flying cover stones. Our study and experience have proven to us that asphalt cements with penetration grades of 200 to 300; penetration grades of from 150 to 200; and penetration grades of 120 to 150 give us the best results when they are applied under conditions which are best suited for each of these grades.

In our area there are four different types of aggregates which are satisfactorily being used. Namely, screened silica gravel; screened limestone gravel; crushed limestone; and lean rock asphalt. In order to accomplish our four objectives it is the consensus of opinion that the following screen analysis gives us the results desired:

Retained on the 3/4" screen	0%
Retained on the 1/2" screen	25 to 50%
Retained on the 10 mesh screen	95 to 100%

varies. In our area, usually this application varies from 0.25 gallon per square yard to 0.35 gallon per square yard.

As is common practice all asphalt shots are started on lateral paper and stopped on lateral paper in order that there will be no overlap at the joints. Immediately after the asphalt is placed the cover material is evenly spread with a mechanical

This analysis is based on the use of round openings in the screen.

Inasmuch as the retainage on the

1/2" screen is the controlling feature of this analysis, a wide variation of the pattern of cover material could be furnished under this specification. Therefore, it is only logical that the rate of asphalt application should be varied as the pattern of aggregate changes. Changes in the application of both asphalt and aggregate will be necessary as the texture and condition of the old pavement type spreader at the rate of approximately one cubic yard of cover material to 90 square yards of pavement. This application of cover material is dependent upon the rate of application of asphalt and the amount of material retained on the 1/2" screen. To say this another way, with this application of rock and the above screen analysis, we strive to obtain an application of stone one rock deep. We have found that it is almost axiomatic (that the less cover material placed, the more cover material we will stick). Each man, both the contractor and the engineer, strives to get a better distribution of aggregate as the job progresses. In fact, at the above rate of application of stone the utmost care must be taken with the cover material or else all of the asphalt will not be covered.

You will remember that one of our objectives was to eliminate the hazard of flying cover material, and contrary to the belief of many engineers we believe in extensive rolling of cover stone. Whether you be from the country or from the city, everyone knows that the time to brand a calf is while the branding iron is hot. It is our opinion that the time to embed cover material into a membrane of asphalt is to do it while it is hot.

Our current seal coat in the district consisted of approximately 210 miles. We did not have flying cover material. We had at our disposal at all times immediately behind the spreader box five steel wheel rollers, with a manufacturer's rated weight of from seven to ten tons. A tabulation of our records show that the entire surface of our seal coats are covered on an average of twenty-five times with the steel wheel rollers. Complementing the steel wheel rolling sufficient pneumatic tired rollers are used to bring the asphalt near the surface. The completed seal coat is thereby accomplished in one day with the exception that the following morning a rotary broom is used to sweep the pavement clean of any loose material that might have been able to stay on the road and not be embedded in the asphalt. It is estimated that after this procedure has been completed there is less than two per cent whip-off.

Yes, we crush some of the larger particles of cover stone. We have not found this objectionable to any extent whatever. You will please be reminded that in the above operations no mention was made of any manipulation of the aggregate after it goes through the spreader box. We refer to the usual procedure of brooming, blading, or both, prior to rolling. Our experience has demonstrated that about all you get out of this operation is the loss of the larger size particles as whip-off. In fact we think the operation does more harm than good.

It is our theory that if a definite pattern of an aggregate is specified by screen analysis, then that same pattern should be indicated by the screen analysis of that material embedded in the asphalt on the road. In our minds, the greatest help that could be given the placement of penetration asphalt pavement would be self propelled, rigidly controlled mechanical spreader which would obtain the same degree of accuracy in spreading cover material as we are now able to obtain with present day distribution in the placing of the asphalt.

While the work is in progress, intelligent, well informed, neat appearing and courteous flagmen should be placed ahead of the operation and at the beginning of the day's operation, asking traffic to drive cautiously through the limits of the construction operation. Flagmen should be so dressed or otherwise identified that he be able to attract the attention of the traveling motorist and indicate to him that he will guide him safely through the hazard involved. So often, the flagmen do not meet a very high standard of qualification. It seems that we fail to remember that the flagmen make more contacts with our customers, the traveling motorists, than perhaps any other man in public work.

In Texas each passing motorist is handed a courtesy card by the flagman which reads as follows:

Please Drive Carefully

You are entering a section of road under construction.
Watch for uncovered asphalt and flying stone.
Please do not pass the car ahead.
We are performing this work without causing you to travel additional miles on a detour.
The inconvenience is regrettable, but we believe you would prefer this method.
The Highway Department is spending $6,000,000 on this type of repair this year in order to keep our roads of a modern standard.

Thank You,
TEXAS HIGHWAY DEPARTMENT

Gentlemen, we have found that careful study in the planning and design stages, good judgment in the application and use of asphalt and rolling to the extent we have described will embed the aggregate into the asphalt so that we will obtain the four desirable characteristics, namely, to provide a seal; to make the pavement nonskid, to secure a uniform texture and color, and to eliminate the hazard liability of flying stone.

With this procedure, we have in the past two seasons sealed approximately 500 miles of road. Bleeding has been negligible, and no expenditure has been necessary for cover material or maintenance during the curing period. In other words, with this procedure we have in effect been able to build a seal coat with characteristics one year old in one day.

There are possibly two objections to the methods and results obtained by this procedure.

1. Rolling costs money.

May we say that broken windshields, wrecked automobiles, personal injuries and fatalities also cost money.

2. Some critics will say that the coarse texture of the surface causes a rumbling noise under

traffic. This is true for the first season. After that it is so minimized that the rumbling is not objectionable. This noise can further be reduced by still more rolling. Perhaps you gather by now that we believe in rolling aggregate into the asphalt while the iron is hot.

I have available here slides that will show the various operations during construction and the texture and appearance of the completed work.

The information covered in this paper appeared in an article in the January issue of Construction and Maintenance Bulletin Number 4.

OTHER SPEAKERS . . .

Mr. D.C. Greer
State Highway Engineer
Texas Highway Department

Mr. J.M. Page
District Engineer
Bureau of Public Roads

Improving Public Relations Through Uniform Use of Signs and Barricades, etc.

The traveling public has either learned to expect or has never known anything different from the presently well maintained and easily traveled state highways. Signs and barricades used on these highways are the final touch in moulding the public's opinion of us and our work. They therefore may be a major factor in improving Public Relations. The subject of Public Relations, in general, has been discussed in a previous Short Course. Public Relations, even in the limited phase as considered in this discussion, is somewhat abstract and it is felt that a general discussion of this phase would not be of particular interest, but that a review and analysis of specific instances of the public's attitude and reaction toward our signs and barricades would be of more interest and certainly of more value.

First, however, I think that we should consider briefly the basic subject, Public Relations; that is the public's relation to the use of roads as it is affected by signs. The increase in the use of automobiles for travel in the past 35 years has brought about a revolution in the public's attitude toward road signs. Prior to 1915 the traveler did not look toward a governmental agency for road signs. Even up to about 1920 there was little in the way of directional information furnished by governmental agencies. Between 1915 and 1920 the need for directional information along roads was so urgent that organizations undertook to mark roads for interstate and transcontinental travel. For example, we might cite the "King of Trails" which was marked by individual organizations from Winnepeg, Canada, to the Gulf of Mexico. Similar marking was made for the "Colorado to Gulf" route. These markings were financed through popular subscription and individual donations of work by interested

W. W. FINLEY, *District Engineer*
Texas Highway Department
Fort Worth, Texas

people along the routes. A great deal of rivalry was generated in the establishment of such routes. As a matter of fact, the marking of a route for a distance of twenty miles or more each way, was considered a small price to pay for having one of these routes pass through a city or town. These markings superceded old logs such as were available from the American Automobile Association which described the route in detail in a rather bulky form. The new route markers were painted on fence posts, telephone posts, buildings, etc. which made the route reasonably clear to any traveler of that day, whereas the old directions available from the American Automobile Association which read, for example, "Go South 2 Miles"; "Turn West at Red Barn"; "Go West 1/2 Mile"; and "Turn South after Crossing Iron Bridge," etc., while more detail, were available to comparatively few people.

The automobile traveler of that day felt that a milestone had been reached when trails such as mentioned above had been marked throughout its entirety. He was well satisfied with the marking and in most instances his faith was justified because the marking had been done by individuals, from the individual's viewpoint, and with plenty of paint and time. With the broadening of the idea of public responsibility for the construction and maintenance of public roads, and subsequently the assumption of marking of public roads by state agencies, the individual's attitude toward marking has undergone a complete transformation. From a situation of being satisfied to start out on an automobile trip with the intention of inquiring as to the route as he goes along or following one of the marked routes mentioned above, the vehicle operator now has learned to expect the utmost in information and warning from the sign element of the roads. Instead of being willing to stop and make inquiry, the driver has now reached the stage where he will write a letter to the Highway Department complaining about a sign being 100 feet too far from where he thinks it should be

Having thus trained or perhaps spoiled the present day driver we approach the matter of obtaining and retaining his good will, which is actually a measure of how efficiently we have performed our functions as such functions pertain to the use of signs on our roads. To accomplish this function, we have over a period of years, 21 to be exact, developed policies and practices in the use of signs which are set out in our Sign Manual. The basic principle of our Sign Manual is Clarity and Uniformity. The proper use of this manual, as it is now constituted, either does, or should, provide the driver with all the information and guidance necessary. Obviously, for many reasons, it is not to be presumed that we can satisfy all drivers. If we can provide signs, barricades, etc., by which the majority of drivers can travel our roads safely, comfortably, and with the minimum of indecision, we have obtained and will retain the good will of these drivers. Have we done so?

The answer to that question can only come from drivers themselves. To get some measure of an answer, questionnaires were passed out to a variety of people in nine counties. The questionnaire contained eleven questions. The questions were arranged to increase the writer's interest, progressively. The questionnaire began with such simple questions as, "Do we use enough signs near barricades?, Are the signs easy to understand?, Are the right kind of barricades used?", and ended with "Here is what I think about signs and barricades as they are used and how I think they should be used." The high proportion returned was remarkable. While the answers to the first ten questions were, in some instances, interesting, it was in response to Number 11 that some let down their hair and told what they really thought about our signs and barricades. From an analysis of their statements we can determine what drivers expect in the way of signs and barricades, and by comparison with our current practices, we can determine wherein we do and wherein we do not provide the service expected by a majority of drivers.

Of those questionnaires returned, sixteen per cent did not answer question Number 11. They apparently were not sufficiently concerned with this problem to bother. Twenty-one per cent gave their O. K. to the whole matter as it is. Twenty-two per cent said they thought our signs and barricades were satisfactory and gave reasons, including comparison to other states. Eight per cent expressed the opinion that drivers should give proper attention to signs as a means of reducing accidents. Thirty-four per cent gave the matter some study, gave definite criticism and offered remedial suggestions.

Of those who demonstrated an actual interest, thirty-nine per cent were reasonably well satisfied and sixty-one per cent offered constructive suggestions for improvement. You will be interested in some of the suggestions. This is the answer of eight people, representing six states, answering in a group:

"Barricades are often left on each side of the highway over long lengths of time when no work is being done. This practice leaves the motorist in doubt and oftentimes will not take heed."

These men, while not saying so in so many words were expressing the general desire for uniform meaning of barricades. If barricades and the pertinent "SLOW" and "CONSTRUCTION AHEAD" signs are observed by a motorist and he goes on past the barricades at the end of the job without seeing evidence of work, his comments are not complimentary to us.

Quoting another answer: "The 'MEN WORKING' signs are not always in the same place." This man continued on to say that these signs should be moved as needed to maintain a reasonably uniform distance from workmen.

A former Maintenance Engineer of this department gave this comment: "Occasionally barricades and signs are put up too far in advance of actual work in that area. This creates a disregard for them and causes some confusion."

These typical answers have one thing in common. In each is the thought of Uniformity; that barricades on the highway should indicate that work is in progress; that "MEN WORKING" signs should be the proper distance from repair crews, not 500 feet some places and a mile in others; that barricades should be reasonably near the actual work, not so far away that the driver forgets he has passed a barricade and is suddenly confronted with work in progress. These deficiencies are not new to us. We have observed them ourselves and in all probability, have had one or more of them called to our attention by letter from an irate driver who expected the signs to be dependable and to mean what they said. The extent to which we reduce such instances will measure the rate of improvement of our Public Relations, as such pertains to signs.

Previously, it is stated that two basic principles of a Sign Manual are Uniformity and Clarity. The previous answers cited had Uniformity as their common theme. Let's see what these people had to say about Clarity. A newspaper editor wrote in part: "Signs of any kind should give clear understandable directions — in wording that a child of say fourteen years of age can interpret. Nothing should be taken for granted in a sign. Most adult people are slow thinkers. Give them instructions that are highly elementary."

This man's answer reflects careful thinking and his point is well taken. Let me illustrate his point. We recently installed an overhead Stop and Go signal in one of the satellite cities adjacent to Fort Worth. The main thoroughfare carries about 15, 000 vehicles per day. For the safety of pedestrians we also installed "WALK" and "WAIT" signals on posts at the pedestrian crossing. On the day this signal was placed in operation, the local City Marshal was watching it when an elderly Negro addressed him as follows: "Boss, when do you cross?", to which the City Marshal replied, "When it says WALK," pointing across the street to the WALK and WAIT signal. After several cycles the Negro said, "Boss, when do it say WALK?" We had placed a signal which was not intelligible to those who are illiterate, to those whose eyesight is defective and to the many children who cross the street and who have not as yet learned to read. The WALK and WAIT lenses were immediately replaced with red and green lenses which are intelligible and understood by practically all people regardless of age or intelligence.

Let us review a couple more answers: "You use the same shape danger sign for most everything. Why not change shape of signs, the more danger, a different shape of sign."

Now we may not agree with this suggestion, and the writer probably had not considered the confusion which would result from multiple shapes of "DANGER" signs. The idea behind the suggestion, that is, that the meaning of a sign should be clear and specific, is well worth our consideration.

Along the same line, and more to the point, is the following statement: "Barricade signs that reflect a necessity for greatly reduced speed should have a glass bead reflector with the safe speed shown large and prominent."

This writer is probably drawing on his own experiences. His thinking is that our signs should be appropriate to the situation and of sufficient size to be noticed. This is just another way to say that signs should be clear in their meaning.

From the three representative statements just discussed which had "Clarity" as their common theme, from the three previously discussed which had "Uniformity" as their theme, and from all six which had the underlying theme of "Dependability," we must conclude that if we are to improve the public's attitude toward our signs and barricades:

1. They must be uniform, so as to be easily recognized.

2. They must be understandable, so as to avoid confusion, and

3. They must mean what they say, to deserve respect.

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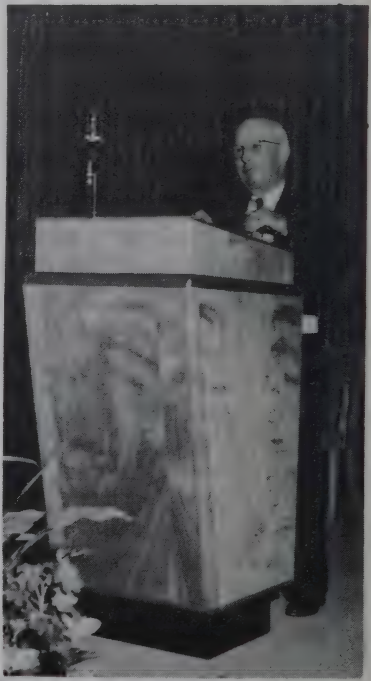
TEXAS HIGHWAY COMMISSION ADDRESSES SHORT COURSE . . .

Mr. E. H. Thornton Jr.
Chairman

Mr. Fred A. Wemple
Member



Mr. Robert J. Potts
Member
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A & M OFFICIALS ADDRESS SHORT COURSE . . .

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Texas A&M College System

Dr. M.T. Harrington,
President,
Texas A&M College

Dr. S.R. Wright, Head,
Civil Engineering Department
Texas A&M College

Reducing Accidents Through Uniform Methods of Handling Traffic

With this subject it seems that we are not the only ones with problems in handling traffic as we all have seen articles dealing with the congested city streets, those in and around industrial plants, and elsewhere. Our problem of protecting our maintenance and construction crews on the highway is very similar to traffic problems of other kinds, as we have the "Human Element" to deal with. It seems the human being is a seething mass of emotional conflicts and as he sits behind the wheel he becomes even more complex. Mr. Milktoast becomes the man he always wished himself to be, the human dynamo. The glib, fast talker lapses into reveries behind the wheel, and so it goes.

That there is a need for something to be done about the problem is hardly debatable; last fiscal year we made five widows and twelve orphans among Highway Department employees alone through this type of accident.

A few weeks ago all districts received copies of proposed Standard Pattern of Barricades and Signs for Maintenance Work. The standard shows four types of positions for barricades and signs which can fit our pattern in general maintenance work. Before we can expect the public to comply with our intentions to deviate his course of travel he must first see our warnings; second, he must see them in time, and third, he must understand them immediately. A lot of our employees actually feel that the traveling public is driving down the road with intent to do him harm, that the usual day's job is one big conflict with the "opposing" motorist. However, for just a moment let's stand on a downtown street curb in your home town. Whom do we see? Yes, there's Mrs. Hackenthorn, double parked sitting at the wheel talking to the president of the Women's Aid Society. Then there is Luther - just passed by. He's the one you sit with at the Club luncheon every week. Yes, in everyone's home town you find the same thing. I still have enough faith in mankind to believe that the vast majority of drivers are willing to co-operate with us in our efforts

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Insurance Division
Texas Highway Department
Austin, Texas

to protect these work crews if we make our setups obvious enough for the least observant to see, and simple and standard enough for the least intelligent to understand. Of course we must allow a margin for the sleepy, the drinking, and other irresponsible drivers.

As we said in the beginning there is little doubt as to whether we should do something about this accident prevention problem. The letter you have read in the back of the current Construction and Maintenance magazine, written by a school teacher in which she tells of the difficulty she encountered when a vehicle she was following suddenly stopped in front of her at a road repair location, is an example of one of many problems. The responsibility she felt toward human lives and property is evident. We told you we made twelve orphans and five widows this last fiscal year. In addition, we also had twenty-six other cases making a total of thirty-one men injured and killed in third party accidents. The insurance cost alone was approximately $54, 000. The National Safety Council has a thumbnail measure by which we can quickly figure a total cost of accidents, that is, by taking the known figure, the insurance costs, and multiplying by four. This is the "hidden cost ratio." With this we get a figure of over $217, 000 for cost of third party accidents alone for the past fiscal year.

STOP
ONE LANE TRAFFIC

25 MPH
ONE LANE TRAFFIC

Maintenance Operations Under Heavy Traffic

GEORGE P. MUNSON JR.
District Maintenance Engineer
Texas Highway Department
Houston, Texas

All roads thus far constructed are expected to wear out some day. That is, the time will eventually come when they can no longer be kept in a passable condition by ordinary maintenance operations and it then becomes necessary to rebuild or to abandon them. As deterioration under traffic progresses, adequate maintenance of the roadbed becomes increasingly difficult and expensive until the time arrives when, in order to keep the road open for traffic, the maintenance man finds himself virtually rebuilding the structure, often from the subgrade up. Thus, while this paper purports to deal with maintenance operations under heavy traffic, it will finally get somewhat into the realm of the rebuilder as well as that of the maintainer Indeed, there is no well-defined boundary between the two. The time allotted is obviously inadequate for a full coverage of the subject, and this discussion will therefore be limited to several phases of what is commonly called "heavy maintenance."

As an example of a locality where maintenance operations are performed on roads which are subjected to very heavy traffic, District 12 of the Texas Highway Department was chosen. This district, composed of eight counties with headquarters at Houston, has a total of 1,444 miles of state-maintained roads which is slightly under the state average per highway district, the latter figure being 1,459 miles. Actual mileage of roads is, however, relatively unimportant to a maintenance organization. The important factors are the intensity and type of traffic moving over these miles. District 12 has an assessed valuation of $1,549,108,004 or 30 per cent of the entire assessed valuation for the state, compared with $205,962,865, the state-wide average assessed valuation per highway district. It has a population of 1,062,414, or 13.8 per cent of the entire state compared with 307,264, the state-wide average population per highway district. These statistics are appropriately reflected in the high traffic intensity of 2,265,611 average daily vehicle miles (1949 figures) for District 12, which is 7 per cent of the total in the state for that year, as compared with 1,282,608 vehicle miles per day, which is the state-wide average per highway district. The data concerning the type and weights of vehicles involved in these statistics are not available. They would, however, undoubtedly show a large proportion of heavy trucks as compared with the state average, in this, the most highly industrialized section of the state.

As of January 1, 1951, there were under state maintenance in District 12, 797 miles of concrete pavement, 588 miles of flexible base with bituminous surfaces and 59 miles of open surface and unsurfaced roads. The problem in this district may therefore be broadly divided into two types of operations, maintenance of flexible base roads with bituminous surfaces and maintenance of concrete pavements.

In common with the other 24 districts, District 12 has a number of miles of roads which are a part of the Farm-to-Market system. They are narrow, often low type flexible bases surfaced with one-course bituminous penetration treatments. For the intensive and heavy traffic which we mentioned at some length above, these roads have proved entirely inadequate. Once the structure is ruptured so that movement of the subgrade and base is apparent, the breakup of the road usually occurs so rapidly that there is little opportunity for the effective use of intermediate measures such as penetration patch sealing and patching with cold-mix asphaltic concrete. The point is quickly reached, therefore, where the problem confronting the maintenance engineer is the virtual rebuilding of his road as cheaply as possible, utilizing to the best advantage the materials which have been placed in the structure in the original construction. This operation has been performed so many times in District 12 in the past few years that it has been reduced to a standard operating procedure. It is accomplished essentially as follows:

1. The existing earth shoulder on one side is bladed out, widening the fill, or flattening the side slope.

2. One half of the old base material is bladed out and onto the other half, and traffic carried on that half and on the remaining shoulder.

3. The exposed one-half of the subgrade is sacrificed and recompacted at the optimum moisture content, using the sheepsfoot roller.

4. The base material is bladed back onto the subgrade and feather-edged out at the new crown line, which should be at least fourteen feet from the center line.

5. These operations are repeated on the other half of the road.

6. Sufficient new base material is hauled in and dumped on the road to give a total compacted depth of base of at least eight inches.

7. This material is shaped and compacted to produce a base width at the top of eighteen to

twenty feet with the total base feather-edged to the road crown.

8. A one-course asphaltic surface treatment eighteen feet wide is placed.

The cost of this type of rebuilding in District 12 during the past year has averaged about $8,000 per mile.

Of the 797 miles of state-maintained concrete pavement in District 12, 80 miles have failed so badly that they have had to be resurfaced. This, of course, reflects the generally recognized inadequacy of the thicknesses of concrete pavements which have heretofore been constructed.

In District 12 we have maintained these pavements as long as is economically practicable by sealing and leveling with cold-mix asphaltic concrete, by undersealing, and by breaking out failed sections and replacing with new concrete.

Undersealing is a somewhat controversial operation, but we believe that its three important functions are:

1. To fill existing voids beneath the pavement slab, thereby eliminating collection of water in these pockets.

2. To give a more uniform bearing beneath the slab tending to eliminate rocking.

3. To form a membrane beneath cracks and joints to inhibit pumping of subgrade material.

The desirability of using this operation for the purpose of leveling pavement slabs appears to be questionable.

In District 12 we use an asphalt slurry composed of eighteen gallons of RC-2 cut-back asphalt and two and one-half sacks of cement per cubic yard of fine sand-silt material. We do not find this to be any better than OA-30 asphalt, but it is considerably cheaper. Our quantities on asphalt slurry underseal jobs usually vary from 50 to 100 cubic yards of slurry material per mile, cost of which is about $18 per cubic yard in place.

Periodic undersealing appears to decrease subgrade pumping materially; however, it is only a partial remedy and a temporary one. We believe that thorough undersealing is desirable and is economically justified where an additional course is to be placed over a partially failed concrete pavement. Its economic justification otherwise is doubtful.

Of the methods currently being used to repair partially failed concrete pavements, the most effective seems to be the breaking out of the failed material and replacement with new concrete. In performing this work, care should be taken that joints between old and new concrete are made perpendicular to the center line of the road. Such joints should extend at least from the edge of the slab to the center joint.

The chief difficulty encountered in concrete slab replacement is the handling of traffic. The curing time required, even where high early strength cement is used, is such that on very heavily traveled roads it is extremely difficult and expensive to adequately take care of the traveling public. In District 12 we are trying to accomplish this at present by the use of "dry batch concrete."

It is a well known fact that not all of the water normally put into a concrete batch is needed for the hydration of the cement. The need for the additional water is caused by the necessity for the lubrication of the concrete mass; in other words, for the production of sufficient paste to insure that the finer particles flow into and completely fill the voids between the coarser materials. Such concrete is said to be "workable" for the conditions under which it is placed.

In making dry mixes it is necessary to mix the concrete with insufficient excess paste for the batch to be workable when placed by ordinary means. Otherwise the batch will be so lubricated that it will be displaced by traffic before the set is attained. In order to create a condition under which this dry batch concrete will be workable, we substitute the tamping action of the heavy air hammer for the normal lubricating action of the excess paste. Our experience has shown that extremely heavy tamping is necessary in placing mixtures of this type. After the broken pavement is removed the subgrade should be excavated to at least eight inches and the dry mix concrete may be placed in two or three courses, depending on the depth. Each course must be vigorously tamped with the air hammer, beginning around the edges of the hole and working toward the center. Tamping of the top course should be continued until the slightest trace of paste rises to the surface of the material, which is about all that can be expected of a mixture of this type. The concrete may then be struck off with a 2-by-4 screed and finished with a wood float. An RC-2 cut-back asphalt seal is then placed and covered with gravel or broken stone. When properly constructed such patches may be used immediately by traffic without apparent displacement. In District 12 we have normally used local aggregates such as iron ore, river gravel, or post oak gravel in this work, using five sacks of cement per cubic yard. On a job where regular concrete aggregates were used and good control of batch proportioning was practicable, a cement factor of five sacks per cubic yard with a water cement ratio of 3.0 gallons per sack and an excess paste of five per cent gave good results.

When concrete pavements subjected to heavy traffic fail to the extent that such measures as those discussed above are necessary, it can be only a matter of time, if the heavy traffic continues, until the most economical remedy is reconstruction of the road surface, utilizing insofar as is possible, the existing concrete. This has been done in District 12, as elsewhere, by placing additional courses over the old slab, consisting of hot-mix asphaltic concrete or a flexible base surfaced with hot-mix asphaltic concrete or some other type of bituminous surfacing. I believe that most engineers responsible for maintenance will join me in recommending that whenever the money is available the latter type of reconstruction is used.

Thus the elapsed time between the initial construction and the reconstruction of a road depends not only on how it was constructed and on the traffic which uses it, but also upon the manner in which it is maintained. It is the duty of the maintenance engineer to make this interval as long as is practicable, consistent with the money he receives for maintenance each year, and with the actual needs of the traveling public.

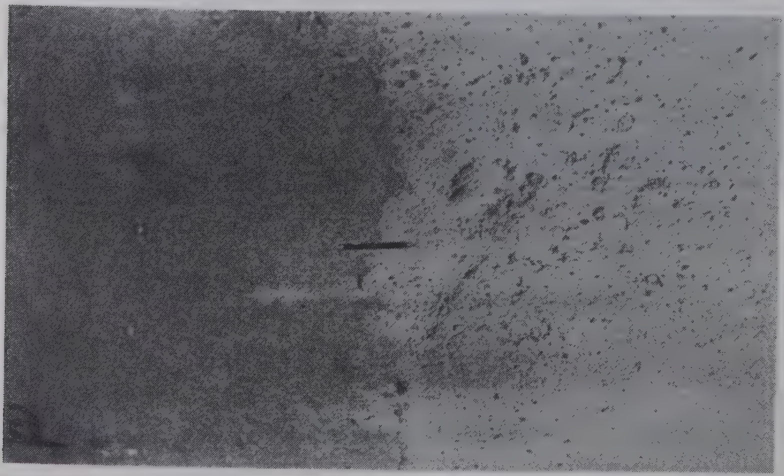
Crew breaking out failed concrete.

Tamping dry batch material.

Striking off dry batch concrete with wooden screed.

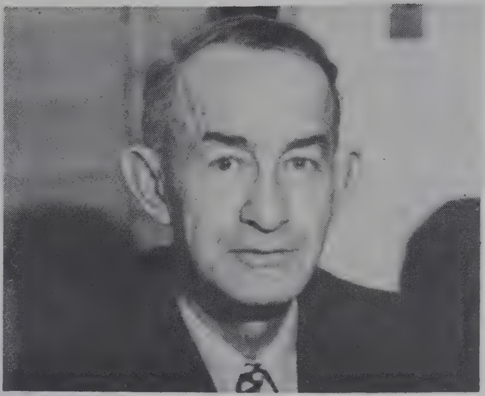
Finished surface.

Joint between finished dry-batch concrete surface and old pavement.



PROGRAM CHAIRMEN

T. C. Collier,
Assistant State Highway Engineer
Texas Highway Department

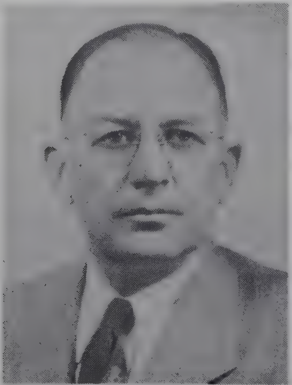


R. J. Hank,
Chief Engineer of Operations
Texas Highway Department

Dr. S. R. Wright, Head,
Civil Engineering Department
Texas A & M College

Herbert Eldridge
Chief Engineer of Planning
Texas Highway Department

Moderator,
Panel Discussion on Maintenance



P. S. Bailey,
Maintenance Engineer
Texas Highway Department

Color Movie,
Discussion of Reproduction Division

R.C. Faltinson, Engineer-Director
Operations Division
Texas Highway Department

Fred J. Benson
Professor of Civil Engineering
Texas A & M College

The success of the 25th Annual Short Course is primarily due to the fine work of Fred Benson.

PROGRAM

Twenty-Fifth

Annual Short Course

in

HIGHWAY ENGINEERING

HELD AT

COLLEGE STATION, TEXAS

All Meetings in Ballroom, Memorial Student Center

WEDNESDAY, MARCH 7, 1951

Morning

Chairman: Dr. S. R. Wright, Head,
Civil Engineering Department
Texas A&M College
College Station, Texas

8:00 Registration, Memorial Student Center

10:30 Address of Welcome
Gibb Gilchrist, Chancellor
Texas A&M College System
College Station, Texas

10:45 Response
Honorable Fred A. Wemple, Member
Texas Highway Commission
Midland, Texas

11:00 Selected Subjects
Dr. M. T. Harrington, President,
Texas A&M College
College Station, Texas

Honorable E. H. Thornton, Jr., Chairman
Texas Highway Commission
Galveston, Texas

Honorable Robt. J. Potts, Member
Texas Highway Commission
Harlingen, Texs

Afternoon

Chairman: Herbert Eldridge,
Chief Engineer of Planning
Texas Highway Department
Austin, Texas

EFFECT OF NATIONAL EMERGENCY ON TEXAS HIGHWAYS

2:00 General Trends
D. C. Greer, State Highway Engineer
Texas Highway Department
Austin, Texas

2:20 The Army and Texas Highways
Colonel George E. Wrockloff, Jr.,
Transportation Officer
Headquarters, Fourth Army
Fort Sam Houston, Texas

2:45 Movement of Military Cargo
G. M. Garrett,
Deputy State Highway Engineer
Texas Highway Department
Austin, Texas

3:05 The Contractors Present Position
F. W. Heldenfels, Jr.,
President, Texas Highway Branch
Associated General Contractors
Corpus Christi, Texas

3:30 Floor Discussion

7:00 Annual Banquet
Student Memorial Center

Toastmaster: General Ike S. Ashburn,
Executive Vice President
Texas Good Roads Association
Austin, Texas

THURSDAY, MARCH 8, 1951

Morning

Chairman: R. J. Hank,
Chief Engineer of Operations
Texas Highway Department
Austin, Texas

9:30 Making Better Use of Existing Highways

M. V. Greer,
Supervising Traffic Engineer
Traffic Services Division
Texas Highway Department
Austin, Texas

9:50 Common Sense Application of Geology in Highway Development

Hubert A. Henry, Research Assistant
Road Design Division
Texas Highway Department
Austin, Texas

10:20 Experience in Construction and Maintenance of Highway-Railroad Grade Crossings

B. M. Stephens, Jr.,
Assistant Chief Engineer
T&NO Railroad Company
Houston, Texas

10:40 Recess

10:55 Highlights of Motor Vehicle Registration Division Operations

E. J. Amey, Director,
Motor Vehicle Division
Texas Highway Department
Austin, Texas

11:10 Design and Construction of Low Water Dips

Joe M. Bingham, Resident Engineer
Texas Highway Department
Mineral Wells, Texas

11:30 Color Movie Showing Phases of Work of Reproduction Division

R. C. Faltinson, Engineer-Director,
Operations Division
Texas Highway Department
Austin, Texas

Afternoon

Chairman: T. C. Collier,
Assistant State Highway Engineer
Texas Highway Department
Austin, Texas

2:00 PANEL DISCUSSION OF IMPROVED PUBLIC SERVICE IN MAINTENANCE OPERATIONS

Moderator: P. S. Bailey, Maintenance Engineer,
Texas Highway Department
Austin, Texas

District 14 Experiments in Reducing Flying Seal Coat Aggregate

H. C. Carter,
District Construction Engineer,
Texas Highway Department
Austin, Texas

Effectiveness of Proper Rolling of Asphalt Penetration Surfaces

J. C. Roberts,
Assistant District Engineer
Texas Highway Department
Abilene, Texas

Improving Public Relations Through Uniform Use of Signs and Barricades, etc.

W. W. Finley, District Engineer
Texas Highway Department
Fort Worth, Texas

Reducing Accidents Through Uniform Methods of Handling Traffic

S. M. Heacock, Safety Instructor
Insurance Division
Texas Highway Department
Austin, Texas

Maintenance Operations Under Heavy Traffic

George P. Munson, Jr.,
District Maintenance Engineer
Texas Highway Department
Houston, Texas

Floor Discussion

* * *